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Building a sustainable bioeconomy in Africa through forest products

TRENDS, OPPORTUNITIES AND CHALLENGES

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Abbreviations

AFR100	African Forest Landscape Restoration Initiative
CAGR	compounded annual growth rate
FLEGT	forest law enforcement, governance and trade
FTE	full-time equivalent
GDP	gross domestic product
GHG	greenhouse gas
ILPLCS	Indigenous and Local Peoples Communities
MAPs	medicinal and aromatic plants
NBS	nature-based solutions
NGO	non-governmental organization
NWFP	non-wood forest product
PES	payment for ecosystem services
PPWP	primary processed wood product
REDD+	Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
SPWP	secondary processed wood product
TLAS	timber legality assurance systems
TPWP	tertiary processed wood product
UNFCCC	United Nations Framework Convention on Climate Change
VPA	Voluntary Partnership Agreement

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Executive summary

Africa is richly endowed with both tropical and non-tropical forests, but its forest resources are under continuous threat, impacting biodiversity, climate change, livelihoods, and economies. These forests play a significant role in the sustenance of the continent's population through the provision of food, energy, medicine, building materials, and income from harvested forest products. However, despite the region's efforts in biodiversity conservation and sustainable forest management, its forest areas face the world's highest deforestation rate, with a net forest loss of 3.9 million ha/year. This rapid rate of deforestation is partly driven by agricultural expansion, animal husbandry, land-use shifts (formal and informal), and fuelwood collection, all of which are influenced by the demands of a growing population, and global demand for agricultural products, wood, and other natural resources.

Forest-based bioeconomies could present a pathway to shift this trend, by ensuring the protection and sustainable use of natural resources while simultaneously supporting communities and livelihoods. The bioeconomy comprises the production, utilization, conservation, and regeneration of biological resources, and includes the forest sector, the focus of this report. Bioeconomies consider the well-being and protection of natural assets alongside the potential economic uses of natural resources, including forests, and contain pathways to address industrial waste, over-exploitation, and emission challenges. Forest-based bioeconomies, based on sustainable forest management, have the potential to curb the effects of deforestation, while creating local economic value and job opportunities. The key lies in realizing and nurturing the significant opportunities for the development of forest-based circular bioeconomies, which can be interpreted as economies that place biological resources at the centre of their production cycle.

The purpose of this report is to present the case for socioeconomic pathways for the development of an African forest-based bioeconomy. It aims to present data on the potential demand for a forest-based bioeconomy in Africa, in order to change the way the sectors related to the forest-based bioeconomy are seen in the region, and to gather momentum toward realizing the existing opportunities. The report is exploratory in nature and meant to encourage further in-depth analysis and verification of the frequently embryonic attempts to quantify the magnitudes of a forest-based bioeconomy.

A high-level top-down approach was used to quantify the 2050 market value and employment opportunities. The figures were obtained based on a model of estimations. Values are intended to provide directional information on existing opportunities. The report does not consider the availability of sustainably harvested forest products. Before any action is taken in response to this report, a thorough supply-side analysis should first be conducted, to ensure market growth is within the natural limits of the ecosystems in question, ensuring no net harm or forest loss.

The forest-based bioeconomy in Africa is considered a unique ecosystem that presents its own set of opportunities and challenges. It can be characterized:

- as a means towards local community socioeconomic development, as opposed to being solely driven by aspirations for conservation, natural resource capitalization, or reindustrialization;

- by major challenges related to high forest loss due to agricultural expansion, logging, mining, fuelwood collection, and other factors;
- by limited integrated value-added industries along forest value chains and continued reliance on the trade in primary forest products;
- by the strong presence of informal markets consisting of small actors and fragmented players providing significant direct income and employment, but constrained by limited know-how, access to technology, and access to finance and markets; and
- by an underdeveloped forest-based circular economy that still produces valuable "waste" material that could be repurposed based on the principles of a circular bioeconomy and cascading use, to both reduce wastage and create opportunities in the form of green jobs as well as sustainably produced goods and services.

In Africa, key forest products contributing to the bioeconomy include wood products, woodfuel, non-wood forest products (NWFPs), and ecotourism. The value chains related to these products contribute to several major economic sectors, namely agriculture, energy, construction, health, manufacturing, and services.

Among these, the following have significant economic potential: (i) increased wood processing; (ii) increased domestic ecotourism; and (iii) the substitution of cement and steel building material for mass timber.

Like many other industries in Africa, wood processing would benefit from increased industrialization and value addition to create more value in the forest sector and provide opportunities for decent work. **The wood processing sector could contribute up to USD 572 billion to the continent's bioeconomy by 2050 and create an estimated 29 million jobs in the same period.**

There is also a promising future for the development of ecotourism in Africa, driven by the growth of domestic tourism in the region, considering subregional disparities. **Ecotourism has the potential to contribute USD 670–740 billion to the African bioeconomy by 2050 and could also create an additional 45–50 million direct and indirect jobs for the sector.**

The substitution of cement and steel building material for structural components in favour of mass timber is an opportunity to decrease greenhouse gas (GHG) emissions and create a more sustainable and carbon-neutral construction sector on the continent. **The increased use of wood building materials has the potential to contribute up to USD 83 billion towards Africa's bioeconomy and an estimated 25 million jobs by 2050.**

Other opportunities identified in this report include: scaling agroforestry for smallholder farmers; tree crop cultivation and commercialization; forest residue biofuel; bioprospecting; collection, cultivation and commercialization of NWFPs, including medicinal and aromatic plants (MAPs); and carbon markets.

Concrete examples showcasing Africa's forest-based bioeconomy opportunities include:

- cement and steel building material substitution in the United Republic of Tanzania;
- wood processing in Gabon;

- forest-based ecotourism in South Africa; and
- forest sector opportunities in Ghana.

Fully tapping into the opportunities provided by a forest-based bioeconomy in Africa requires: (i) safeguarding any bioeconomy-related interventions against the potential creation of harm, taking ecosystem health and functions, society and economy, and climate into account; **and (ii) addressing possible challenges related to sustainable growth** to ensure sustainable demand and supply of harvested forest products.

Furthermore, **to ensure sustainable and inclusive growth of the forest-based bioeconomy in Africa, a number of barriers need to be overcome.** These include: (i) unsustainable harvesting from natural resources, which threatens the future supply of wood and NWFPs; (ii) the limited use of emerging technologies; (iii) limited access to skilled labour; and (iv) unclear land tenure systems.

To further develop the forest-based bioeconomy in Africa, the necessary measures would include: establish innovative public-private partnerships, industrialize the wood sector, develop sustainable plantations, develop targeted bioeconomy policies and legislation, and change how wood energy is approached in Africa.

Simultaneously, it will be critical to ensure that biodiversity is maintained and improved, forest cover is expanded, and negative consequences for the environment, ecosystems, and communities are minimized, thus encouraging sustainable, holistic growth in order to ensure that the African forest-based bioeconomy becomes a driver of transformational change.

Africa's natural and human capital provides unique opportunities to expand the forest-based bioeconomy and to become a driver of transformational change in the region. However, additional efforts, from all stakeholders, are required to address existing challenges, tap into its full potential and allow countries to advance a resilient and rapidly growing forest-based bioeconomy.

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1. Introduction

The purpose of this report is to present the case for socioeconomic pathways for the development of the African forest-based bioeconomy, ensuring that forest economies: (i) adhere to social and ecological safeguards, including no net forest loss, and no net harm to climate, forest ecosystems, communities, or health; and (ii) grow the market for sustainably managed forest products. There is an opportunity to develop a new and green economy in Africa, and the bioeconomy is a critical component of this opportunity. The region has a wealth of forest assets with the potential to greatly impact economic development and sustainability.

As the world strives towards a more ecologically, socially and economically just paradigm, including in the context of the Sustainable Development Goals, Africa has a chance to bypass the mistakes of unsustainable practices and usher in a new period, inspired by Raworth's vision of "doughnut economics". Raworth's idea anchors on creating an environmentally safe and socially just space in which humanity can thrive, irrespective of economic trajectory (Raworth, 2017).

This report aims to present data on the forest-based bioeconomy in Africa in order to change the way the sectors related to the forest-based bioeconomy are seen in the region, and to gather momentum toward fulfilling the opportunities presented for these sectors. Although this report details the opportunities for increased demand in forest products, it does not set out to define the availability of sustainably harvested forest products. It is meant to be exploratory in nature and to encourage further in-depth analysis and verification of the frequently embryonic attempts to quantify the magnitudes of the forest-based bioeconomy in Africa.

Scope

The scope of this report focuses on forest-based products and services, as well as economic, social, and sustainable opportunities in the African forest-based bioeconomy, with a particular focus on sub-Saharan Africa. Although many forest-based value chains are riddled with challenges, they can be sustainable and contribute to a sustainable circular bioeconomy, if properly designed and managed. This report identifies and quantifies the demand-side opportunities present in the African forest-based bioeconomy through the lens of forest-linked economic sectors, namely agriculture, energy, construction, health, manufacturing, and services. It is understood that it is critical to also consider other aspects of forest-based value chains to ensure the sustainable development of the sector.

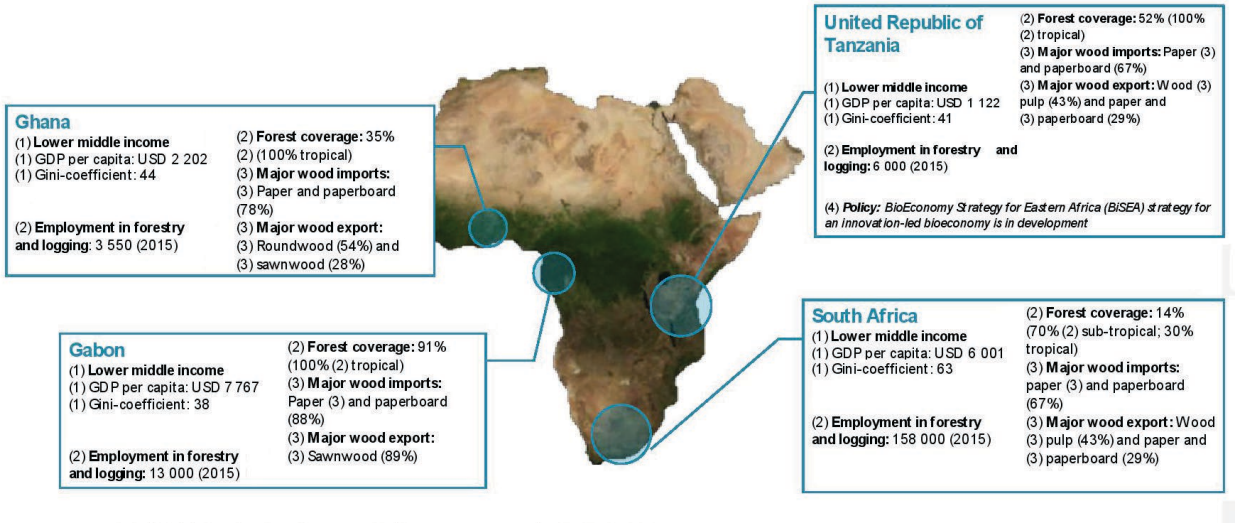
Structure

Through extensive research and opportunity modelling, the report presents the trends, challenges, and opportunities faced by the forest-based bioeconomy in Africa through the following major sections and subsections:

- **Mapping of the forest-based sustainable and circular bioeconomy:** defines the sustainable and circular bioeconomy, highlighting the major value chains of products and services that stem from it and identifying the major associated economic sectors.
- **Forest-based products and services:** highlights priority forest-based products and services based on desktop research.
- **Forest-based bioeconomy socioeconomic impact, trends, and challenges:** presents the socioeconomic impact of the forest-based bioeconomy based on an internal assessment, the trends, and the challenges faced in the provision of these products and services in the African forest-based bioeconomy.
- **Opportunities in the forest-based bioeconomy:** identifies and assesses opportunities – based on desk research – for their potential economic, employment, and ecological impact.
- **The case for Africa's forest-based opportunities:** contextualizes the implementation of the identified opportunities using case study countries that further analyse the potential impact and provide a context for implementation.
- **Challenges related to Africa's forest-based bioeconomy**: analyses key risks of the transition to a forest-based bioeconomy and proposes potential mitigation interventions.

To ensure a detailed analysis, four case study countries across the various regions of Africa are discussed throughout the report, as examples of the opportunities mentioned. As seen in Figure 1 and Figure 2, Gabon, Ghana, South Africa, and the United Republic of Tanzania are representative of different biomes present in Africa. The countries have different socioeconomic conditions and forest land coverages, as well as diverse and unique forest and wooded land characteristics. For example, the United Republic of Tanzania has large bamboo and mangrove forest areas as well as forest areas under protection. South Africa dedicates a significant proportion of its forest area to plantations and has large non-forest wooded lands. These case study countries have archetypal characteristics that can be extended to other African countries to gauge the prospects of challenges and opportunities. All the case countries have policies supporting sustainable forest management, with varying degrees of implementation and success. These countries are further profiled below.

Figure 1. Case study countries


Ghana
(1) Lower middle income
(1) GDP per capita: USD 2 202
(1) Gini-coefficient: 44
(2) Employment in forestry and logging: 3 550 (2015)
(2) Forest coverage: 35%
(2) (100% tropical)
(3) Major wood imports:
(3) Paper and paperboard (78%)
(3) Major wood export:
(3) Roundwood (54%) and
(3) sawnwood (28%)
United Republic of Tanzania
(1) Lower middle income
(1) GDP per capita: USD 1 122
(1) Gini-coefficient: 41
(2) Employment in forestry and logging: 6 000 (2015)
(2) Forest coverage: 52% (100% (2) tropical)
(3) Major wood imports: Paper (3) and paperboard (67%)
(3) Major wood export: Wood (3) pulp (43%) and paper and (3) paperboard (29%)
(4) Policy: BioEconomy Strategy for Eastern Africa (BiSEA) strategy for an innovation-led bioeconomy is in development
Gabon
(1) Lower middle income
(1) GDP per capita: USD 7 767
(1) Gini-coefficient: 38
(2) Employment in forestry and logging: 13 000 (2015)
(2) Forest coverage: 91% (100% (2) tropical)
(3) Major wood imports: Paper (3) and paperboard (88%)
(3) Major wood export: (3) Sawnwood (89%)
South Africa
(1) Lower middle income
(1) GDP per capita: USD 6 001
(1) Gini-coefficient: 63
(2) Employment in forestry and logging: 158 000 (2015)
(2) Forest coverage: 14% (70% (2) sub-tropical; 30% tropical)
(3) Major wood imports: paper (3) and paperboard (67%)
(3) Major wood export: Wood (3) pulp (43%) and paper and (3) paperboard (29%)

Notes: Imports and exports are USD percentages; policies are specific to the bioeconomy.

Sources: Author's elaboration based on:

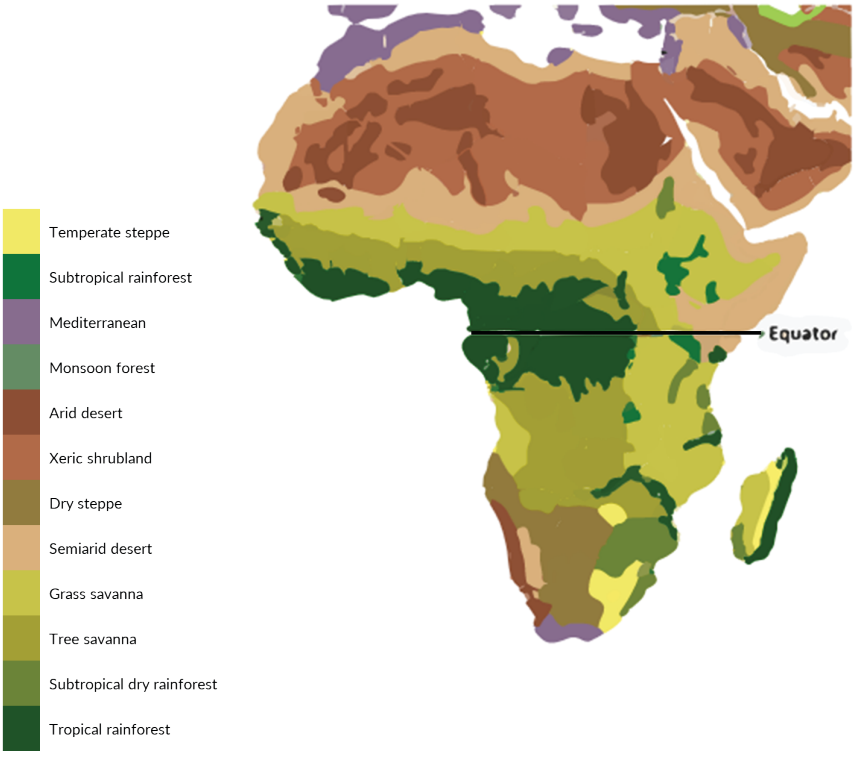
(1) World Bank. n.d. World Development Indicators. [Accessed on 2021]. https://databank.worldbank.org/source/world-development-indicators

(2) FAO. 2020. Global forest assessment: Ghana. Rome, FAO. https://openknowledge.fao.org/server/api/core/bitstreams/44e14467-5379-4c8d-a8cd-711f23038d10/content
FAO. 2020. Global forest assessment: United Republic of Tanzania. Rome, FAO. https://openknowledge.fao.org/server/api/core/bitstreams/480b30fa-dd26-4427-9d68-8a07640946c9/content
FAO. 2020. Global forest assessment: Gabon. Rome, FAO. https://openknowledge.fao.org/server/api/core/bitstreams/3eff2288-0c53-4fd8-ad10-b3f417b71836/content
FAO. 2020. Global forest assessment: South Africa. Rome, FAO. https://openknowledge.fao.org/server/api/core/bitstreams/44cfbcc0-4001-48d3-8f77-66d8cad80d00/content

(3) FAO. 2021. FAOSTAT: Forestry Production and Trade. [Accessed on 2021]. https://www.fao.org/faostat/en/#data/FO. Licence: CC-BY-4.0.

(4) International Advisory Council on Global Bioeconomy. 2020. Global Bioeconomy Policy Report (IV): A decade of bioeconomy policy development around the world. https://gbs2020.net/wp-content/uploads/2021/04/GBS-2020_Global-Bioeconomy-Policy-Report_IV_web-2.pdf

Figure 2. Vegetation landscape in Africa



Source: Koistinen, V. 2009. Vegetation Africa. Cited September 2021. https://commons.wikimedia.org/wiki/File:Vegetation_Africa.png

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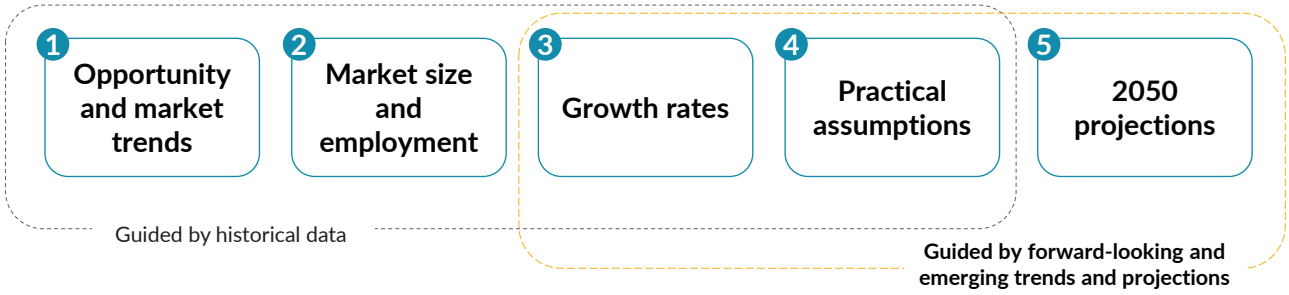
2. Methodology



The study is based on literature review and a high-level top-down approach to quantify the 2050 market value and employment opportunities. The figures were obtained based on a model of estimations and are intended to provide directional information on existing opportunities.[1] A more tailored analysis will be required to determine the potential of specific sectors and countries. See annex A for further information.

The detailed assumptions used were calculated using:

1. **Opportunity and market trends**: research through literature review was conducted to gather information on the trends and challenges in the relevant sector(s) for the highlighted African forest-based bioeconomy opportunities.
2. **Market size and employment:** information on the 2020 market size was obtained to assess opportunities, using historical data to estimate the present market size where data was not available. The study also obtained these values for the number of people directly, and where possible, indirectly employed in the relevant sector(s) in 2020.
3. **Growth rates**: estimates were generated for the rate of market growth using historical market data or projected values for long-term market growth trends where data was available. The market size was used as a proxy to determine the growth of the number of people employed in the sector, while employment growth rates were used where data was available. It is worth noting that significant changes in the forest-based labour market, such as labour intensity and mechanization, may involve changes to the estimates presented in the report.
4. **Practical assumptions**: assumptions were made by gathering research data, or proxy regions and countries whenever data was not available. Many ongoing assumptions were assumed to remain constant unless projections were available, or if economic shocks were expected to stabilize. These are presented in Table A.1.
5. **2050 projections:** annual data was extrapolated using the above information to generate directional models of estimations for the market value and employment in the relevant forest-based bioeconomy sectors in Africa.

Throughout the report, all estimates of potential market demand, economic value, and potential job creation have been calculated based on the potential scale of these sectors without considering the availability of sustainably harvested forest products within a

[1] This methodology does not consider the availability of sustainably sourced forest products (the supply-side analysis). As such, the realized market size across sectors may vary substantially in different subregions, as it is subject to land availability, forest cover, tree species, forest management systems, sustainable harvesting ratios, and legal policies.

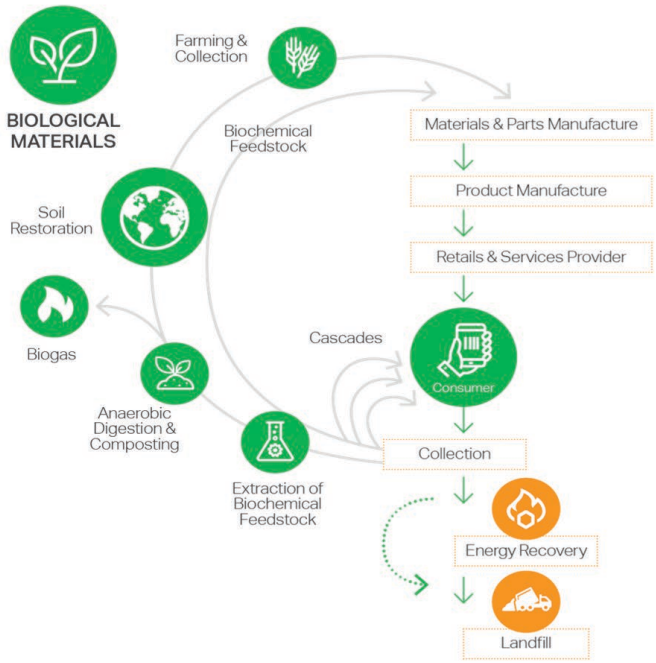
particular subregion. This supply-side availability may limit the potential market size, as there are real limitations to the sustainable growth of forest product supply, including land availability, forest cover, tree species, sustainable harvesting, and legal policies (which govern both land use, forest ownership, and harvesting). Before any action is taken as a result of this report, a thorough supply-side analysis should be conducted to ensure that: (i) market growth is within the natural limits of the ecosystem; and (ii) all forest-based economies adhere to social and ecological safeguards.

3. Mapping the forest-based sustainable and circular bioeconomy

The bioeconomy comprises the production, utilization, conservation, and regeneration of biological resources, and includes the forest sector, which is the focus of this report (FAO, 2021). The Global Bioeconomy Summit Communiqué definition of the bioeconomy comprises various activities and value chains across most major economic sectors. Even when specifically mapping forest biological resources, the broad range of interwoven value chains includes the primary production of biomass, industries processing biomass (bioprocessing), and service operations linked to biological resources (European Commission, 2021). For this analysis, forest-based products and services will include all goods and activities that stem from the forest (FAO, 2000).

A sustainable and circular forest-based bioeconomy is based on sustainable practices, end-of-cycle uses for products, use of waste and by-products, and regenerative cycles. It takes into consideration the environmental and socioeconomic impact of activities and services conducted. It also ensures that local and global impacts on health, food, water, income, energy, conservation, and climate change are not detrimental to future supply for the population. In addition to this, a sustainable and circular bioeconomy also takes opportunities to implement end-of-life use of products and by-products within the bioeconomy and aims to include regeneration, as seen in Figure 3. These principles are interlinked, as circularity in the ecosystem is a form of sustainability practice.

Figure 3. Example of a circular and sustainable forest-based bioeconomy



Anaerobic digestion - The process by which micro-organisms break down biological material in the absence of oxygen to generate products such as fertilizer and energy that can be returned to a natural systems

Circular and sustainable bioeconomy

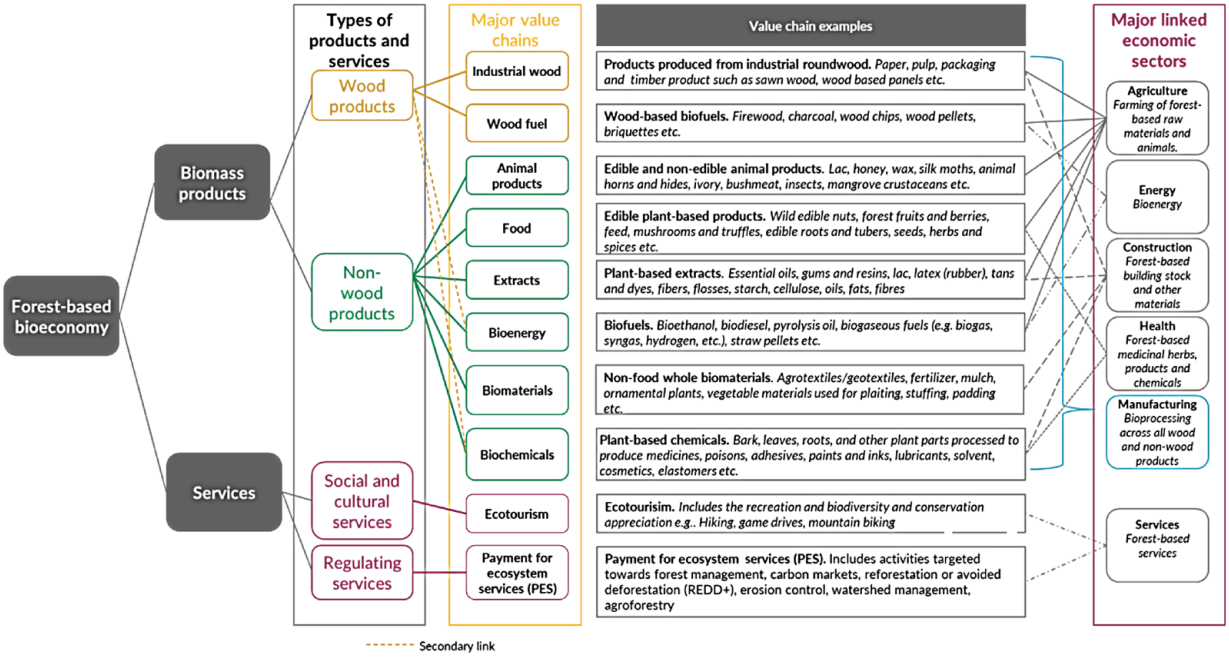
A system that consists of feedback loops by encouraging end-of-life product use that supports circularity to **limit waste and pollution** and **keep materials in use.**

Unlike the consumption of other materials, biological materials are also **regenerative** because they are able to **return to a natural system.** This regeneration can be used to rebuild and restore these natural ecosystems.

Source: Ellen MacArthur Foundation. 2013. *Towards the circular economy Vol. 1: an economic and business rationale for an accelerated transition*. Ellen MacArthur Foundation, Newport. https://www.ellenmacarthurfoundation.org/towards-the-circular-economy-vol-1-an-economic-and-business-rationale-for-an

The forest-based bioeconomy can be segmented into five types of direct products and services that stem from forest resources. These consist of wood products, NWFPs, social and cultural services, and regulating services, as seen in Figure 4. These can be further segmented into major value chain categories. The products from these value chains contribute to several major economic sectors, namely agriculture, energy, construction, health, manufacturing, and services (also seen in Figure 4).

Figure 4. Products and services of the forest-based bioeconomy


Forest-based bioeconomy
Biomass products
Services
Types of products and services
Wood products
Non-wood products
Social and cultural services
Regulating services
Major value chains
Industrial wood
Wood fuel
Animal products
Food
Extracts
Bioenergy
Biomaterials
Biochemicals
Ecotourism
Payment for ecosystem services (PES)
Value chain examples
Products produced from industrial roundwood. Paper, pulp, packaging and timber product such as sawn wood, wood based panels etc.
Wood-based biofuels. Firewood, charcoal, wood chips, wood pellets, briquettes etc.
Edible and non-edible animal products. Lac, honey, wax, silk moths, animal horns and hides, ivory, bushmeat, insects, mangrove crustaceans etc.
Edible plant-based products. Wild edible nuts, forest fruits and berries, feed, mushrooms and truffles, edible roots and tubers, seeds, herbs and spices etc.
Plant-based extracts. Essential oils, gums and resins, lac, latex (rubber), tans and dyes, fibers, flosses, starch, cellulose, oils, fats, fibres
Biofuels. Bioethanol, biodiesel, pyrolysis oil, biogaseous fuels (e.g. biogas, syngas, hydrogen, etc.), straw pellets etc.
Non-food whole biomaterials. Agrotextiles/geotextiles, fertilizer, mulch, ornamental plants, vegetable materials used for plaiting, stuffing, padding etc.
Plant-based chemicals. Bark, leaves, roots, and other plant parts processed to produce medicines, poisons, adhesives, paints and inks, lubricants, solvent, cosmetics, elastomers etc.
Ecotourism. Includes the recreation and biodiversity and conservation appreciation e.g.. Hiking, game drives, mountain biking
Payment for ecosystem services (PES). Includes activities targeted towards forest management, carbon markets, reforestation or avoided deforestation (REDD+), erosion control, watershed management, agroforestry
Major linked economic sectors
Agriculture Farming of forest-based raw materials and animals.
Energy Bioenergy
Construction Forest-based building stock and other materials
Health Forest-based medicinal herbs, products and chemicals
Manufacturing Bioprocessing across all wood and non-wood products
Services Forest-based services
Secondary link

Source: Dalberg Catalyst analysis, 2021. Authors' elaboration

It is important to recognize that, given Africa's unique continuum of informal to formal economic profiles, with over 80 percent of employment in the informal sector (Guven and Karlen, 2020), determining finite formal market size projections in the African bioeconomy remains a challenge. What is clear however is that given the inexorable developmental demands presented by global consumption patterns and demographic change, the bioeconomy can serve as a profound foundation for ecological renewal, and the creation of sustainable, low-carbon-intensity livelihoods.

4. The forest-based bioeconomy in Africa

Forest-based bioeconomy trends and challenges

Africa is richly endowed with both tropical and non-tropical forests (e.g. savannahs, dryland forests, natural forests, and plantations). Forests and wooded land cover 36 percent of land area in Africa, consisting of 637 million ha of forest, and 446 million ha of wooded land (FAO, 2020b). This area includes tropical and subtropical forests, such as moist forests, dry forests, mangroves, miombo woodlands, and mixed land consisting of shrubs, bushes, and trees (FAO, 2020a). The location of the majority of the forest area in the region excludes northern Africa, which, like many low-forest cover countries, is nevertheless rich in NWFPs, while the majority of wooded land is located in eastern and southern Africa. For example, 41 percent of land area in South Africa is considered to be other-wooded land that accounts for less canopy coverage than forests (FAO, 2020b).

The majority of forest land in the region is under public ownership, but Indigenous Peoples and local communities have rights to a significant portion of private forests. As of 2020, an estimated 24 percent and 19 percent of forest land area in Africa is used for biodiversity conservation and production respectively, while 21 percent is designated for multi-use. Private land ownership in Africa is relatively low compared to other regions, accounting for 5 percent of forest land area. Unlike Europe and other regions such as Asia and Central America, private land ownership is predominately (85 percent) owned by local, tribal, or Indigenous Communities as opposed to individuals and businesses (FAO, 2020b). Land and resource rights are fundamental to a successful, sustainable, and equitable bioeconomy, and influence the types of partnerships formed between companies and rural communities, prior informed consent, as well as the effectiveness of benefit sharing by companies and governments in forested areas.

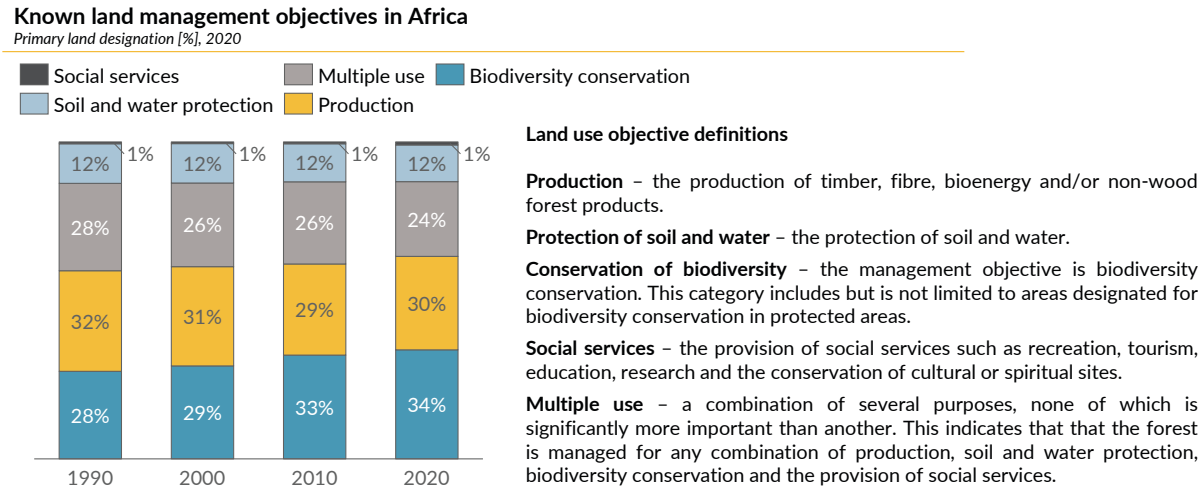
Over the past decade, Africa's forests have suffered the highest level of net forest loss globally, largely attributed to a growing population requiring more land and resources from natural forests. Between 2010 and 2020, Africa had the highest annual rate of net forest loss of -3.9 million ha/year, overtaking South America, which had the next highest rate of -2.6 million ha/year. This rate in the region has been increasing since the 1990s, driven by forest loss in eastern and southern Africa over the past decade. The main drivers of deforestation in Africa between 2000 and 2018 were cropland expansion, livestock grazing, and urban and infrastructure development, all influenced by the demands of a growing population (FAO, 2022b). Fuelwood is widely used in the region and, along with charcoal, is also used in informal industries that make it difficult to monitor forest harvesting (Mayaux *et al.*, 2013).

Additionally, climate change will most likely affect forest growth and productivity. Climate change has impacted forest areas and will continue to affect forest growth, decomposition rates, productivity, the intensity of natural disturbances, land-use patterns, and other ecological disturbances directly and indirectly through changes in temperature, rainfall, weather, and other factors (United States Environmental

Protection Agency, 2017; Nabuurs *et al.*, 2007; IPCC, 2019). As global temperatures continue to rise, the length of the growing season could increase, and the risks of drought in some areas and extreme precipitation and flooding in others will most likely be higher. While the nature of the effects is an evolving topic, insect outbreaks and the occurrence of invasive species are expected to be more frequent (IPCC, 2007; IPBES, 2019). Additionally, climate change will accelerate habitat loss and land fragmentation, and the land suitable for forests will continue shrinking due to the rising demand for food and biofuels. In the United Republic of Tanzania alone, the extent of montane forest is projected to almost halve by 2085 under the optimistic scenario and microhabitat forests (i.e. thickets), are projected to incur losses exceeding 70 percent over the same period (John *et al.*, 2020).

African governments have acknowledged the role of forests in socioeconomic development, which has resulted in increased land for biodiversity and conservation. As seen in Figure 5, land use for biodiversity and conservation has been increasing in the region, while land for production activities has been decreasing. Over the last two and a half decades, governments in the region have been acknowledging the critical role forests could play in fostering greater socioeconomic development, and have increasingly adopted forest planning and management policies, legislation, and frameworks (Africa Forest Forum, 2019). Non-governmental organizations (NGOs) and the private sector have also increasingly been working with governments on the management of protected areas in Africa and conservation efforts on private and community lands have also been increasing in recent years. However, COVID-19 poses a threat to the provision of adequate management for these areas due to funding being redirected toward other pressing government objectives and decreased income from tourism (Lindsey *et al.*, 2020).

Figure 5. Primary land designation in Africa


Known land management objectives in Africa
Primary land designation [%], 2020
Social services
Multiple use
Biodiversity conservation
Soil and water protection
Production
12%
1%
28%
32%
28%
12%
1%
26%
31%
29%
12%
1%
26%
29%
33%
12%
1%
24%
30%
34%
1990
2000
2010
2020
Land use objective definitions
Production – the production of timber, fibre, bioenergy and/or non-wood forest products.
Protection of soil and water – the protection of soil and water.
Conservation of biodiversity – the management objective is biodiversity conservation. This category includes but is not limited to areas designated for biodiversity conservation in protected areas.
Social services – the provision of social services such as recreation, tourism, education, research and the conservation of cultural or spiritual sites.
Multiple use – a combination of several purposes, none of which is significantly more important than another. This indicates that that the forest is managed for any combination of production, soil and water protection, biodiversity conservation and the provision of social services.

Notes: Primary land-use data is available for slightly less than 50 percent of forest land in Africa.
Source: FAO. 2020. *Global Forest Resources Assessment 2020: Main report*. Rome. https://doi.org/10.4060/ca9825en

Forest products and services can provide substantial contributions to the continent's social and economic growth if managed sustainably. Local forested areas have the potential to meet both the commercial and subsistence needs of the region. Local farmers depend on these areas for food, energy, medicine, and a wide range of other purposes, and

forests contribute to household revenue in many communities. In many tropical countries, forest-adjacent people earn about one-quarter of their income from forests. For example, a large-scale study of five countries in sub-Saharan Africa found that one-third of rural smallholder households grow trees, which contribute an estimated 17 percent of the total annual gross income of these households (Miller, Muñoz-Mora and Christiaensen, 2017). African forests directly support an estimated 60 million people living in rural areas, and an additional 40 million in urban areas (Mayaux *et al.*, 2013). However, not all forested areas are sustainably managed. In some areas, a lack of adequate management structures and poor implementation have led to a loss of forest cover, impacting both environmental concerns and future forest growth. Competing land interests (including with agriculture), poor forest management and usage (including both deforestation and forest fires), and inadequate community involvement have placed forested areas at risk, limiting their ability to contribute to the continent's social and economic growth.

Employment in the forest sector in Africa is largely informal, and formal employment has remained relatively stagnant in the region, contrary to global trends. The (formal) forest sector directly contributed more than USD 22 billion to African gross domestic product (GDP) in 2015. Taking into account the total economic effects (i.e. direct, indirect, and induced economic contributions), including demand on other sectors and expenditure on labour income, the forest sector contributed more than USD 48 billion to national economies in Africa in 2015. The estimated combined direct contribution of the formal and informal forest sector to employment in the 2017–2019 period was 4.7 million jobs in Africa (based on 54 countries; data excludes furniture manufacture). In Africa, as in other parts of the world, the majority of people were employed in the "manufacture of wood and wood products" subsector (FAO, 2022a).

Globally, the number of people employed in forest-related activities decreased by around 15 percent from the period 2011–2013 to 2017–2019. In Africa, a slight increase could be observed from 4.1 million jobs in 2011–2013 to 4.7 million jobs in 2017–2019 (Lippe *et al.*, 2022). Informal employment accounts for a significant proportion of forest-related employment, particularly in the Global South. In Africa, as well as Asia and Oceania, the share of informal employment is above 80 percent of total forest-related employment (ibid.). Forest product processing activities globally generate more employment than forestry (primary activities). For every 100 jobs in the sector in 2015, 73 additional jobs were supported (on average) in the national economy (FAO, 2022a). In Africa, it was estimated that there are three jobs in forest processing for every forest-related job, while comparatively, this ratio was estimated to reach 4:1 or 5:1 in developed markets (FAO, 2008).

The gross value-add from the formal and informal forest sector in Africa was estimated to be USD 36.3 billion in 2011. Most of the value in the formal wood sector in Africa is generated from roundwood production (accounting for 65 percent of the value). Informal income from the sector has been difficult to consolidate, but important value chains such as fuelwood (including charcoal, biochar, etc.) and construction activities are estimated to contribute about USD 3.7 billion, USD 10.5 billion and USD 122 million, respectively (FAO, 2014). However, the African Development Bank (African Natural Resources Centre, 2021a) reports that:

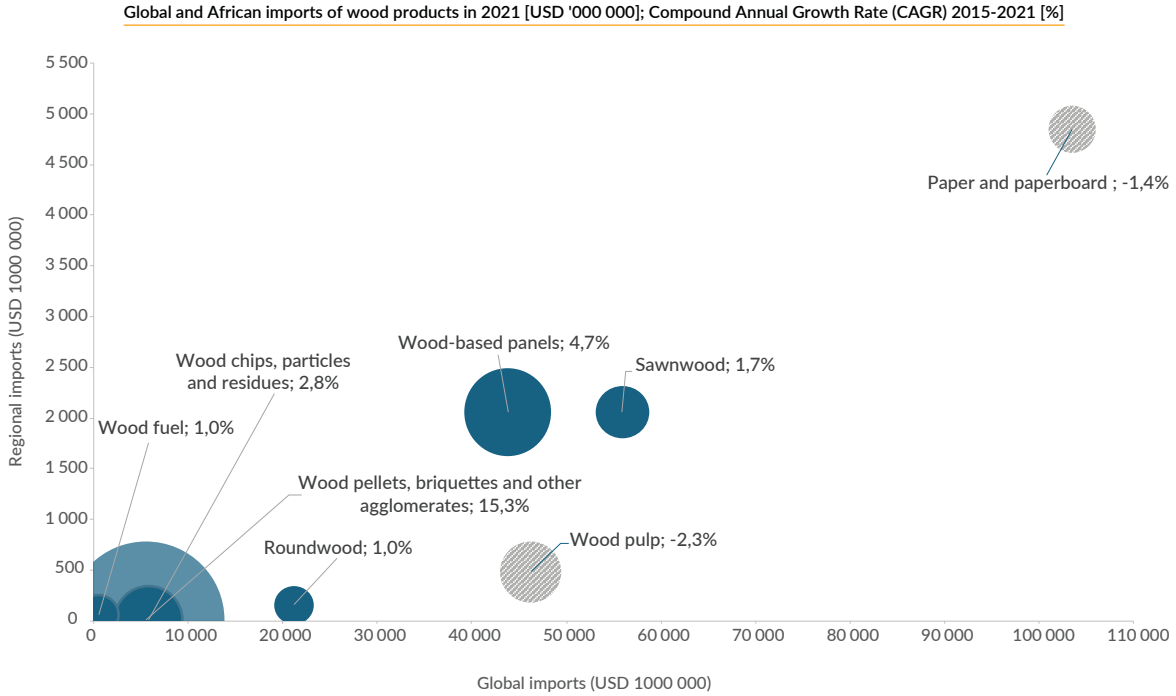
> Based on the current demand, industrial wood is projected to grow from about 77 million m^3 per year today to 300 million m^3 per year by 2030 and supply from 46

million m^3 to 81 million m^3 per year during the same period (Indufor Oy and Criterion Africa Partners, 2017). The supply gap of 219 million m^3 by 2030 in Africa will be met by global wood imports unless forest production and industrialization are sufficiently enhanced to match the growing demand. To meet the growth in demand for wood, the annual establishment of over 300 000 new hectares of planted forests will be needed, based on an assumed growth rate of 18 m^3/ha/year (ibid.). This justifies the need to invest in the establishment of plantation forests of desirable timber tree species to ensure the sustainable supply of raw materials to burgeoning African timber industries.

The sustainable management of both existing natural and planted forests and newly established forests, including the restoration of forests and landscapes, will therefore be necessary to satisfy future demand while ensuring the ecological and socioeconomic function of forests.

Trade in wood products demonstrates a high regional and global demand for paper, paperboard, sawnwood, and wood-based panels. Figure 6 shows that paper and paperboard as well as sawnwood and wood-based panels are highly traded wood products both globally and regionally in Africa. Despite the high import values, the production of paper and paperboard – for example, graphic papers, sanitary and household papers, and packaging materials – has decreased in the region. This is aligned with global trends for graphic papers, where the decrease in demand has been attributed to digitalization. Wood-based panels are another important product in regional and global wood trade, and production in Africa has significantly increased in recent years (Compound Annual Growth Rate [CAGR] 4.7 percent between 2015 and 2021), surpassing the global CAGR of 2.0 percent for the same period (global value not shown in Figure 6). The product is not significantly exported in the region but has potential for future trade.

Figure 6. Global and African import of wood products

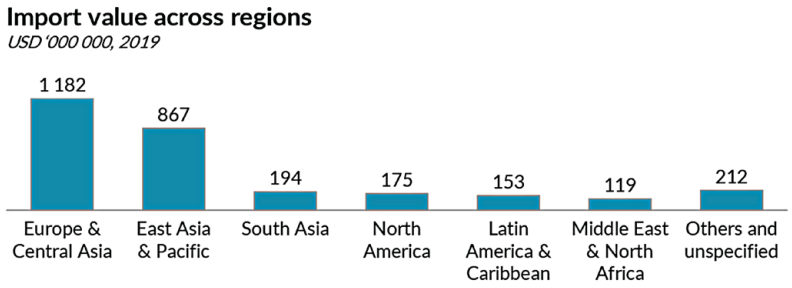


Note: The bubble size represents the Compound Annual Growth Rate (CAGR) 2015- 2021. Patterned bubbles indicate a negative CAGR.
Source: FAO. 2022. FAOSTAT: Forestry Production and Trade. [Accessed on 2024]. https://www.fao.org/faostat/en/#data/FO.Licence: CC-BY-4.0.

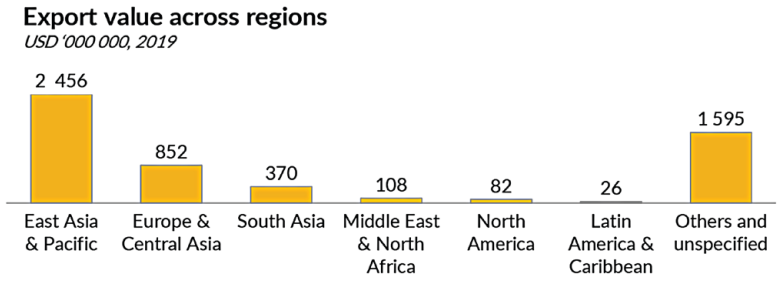
Europe and Central Asia and East Asia and Pacific are important wood trading partner regions for sub-Saharan Africa (Figure 7). Asian countries, specifically China, India, and Indonesia, account for significant trade in formal exports and imports for the region. China in particular has invested substantially in timber supply chains in Africa in order to grow trade with the region, turning timber-rich countries in the Congo Basin and miombo woodlands in southern Africa and eastern Africa into major import partners (Weng *et al.*, 2014).

Figure 7. Import and export value of wood forest products into/from sub-Saharan Africa

Europe & Central Asia (~41%) and East Asia & Pacific (~30%) account for the majority of forest product import value into sub-Saharan Africa.
China is the largest import partner, accounting for ~15% of forest product import value, followed by Indonesia, India and Sweden, who jointly account for an additional 19% of import value.



East Asia & Pacific (~45%) and Europe and Central Asia (~16%) also account for the majority of forest product export value in sub-Saharan Africa.
China is also the largest export partner, accounting for ~34% of forest product export value, followed by India, Viet Nam and Indonesia who jointly account for an additional 14% of export value.



Source: FAO. 2020. FAOSTAT: Forestry Production and Trade. [Accessed on 2020]. https://www.fao.org/faostat/en/#data/FO. Licence: CC-BY-4.0.

The forest-based bioeconomy in Africa is a unique ecosystem that presents its own set of opportunities and challenges.

- **The African forest-based bioeconomy presents a unique ecosystem that differs from the well-mapped and regulated economies found in developed markets.** It is seen in the region as a means towards local community socioeconomic development, as opposed to being solely driven by aspirations for conservation, natural resource capitalization, or reindustrialization. This is also evident in the social sustainability aspects found in bioeconomy-related strategies in the region (Rosa and Martius, 2021). The heavy dependency of these local communities on forests for their livelihoods, and the land ownership claims of these groups, further emphasize the role of local communities in forest-based value chains. The forest-based economy in the region should therefore support existing local and regional bioeconomies and serve the priorities of Indigenous Peoples and local communities in addition to the broader goals of sustainability, conservation, and natural resource capitalization.
- **A major challenge in the region is the high forest loss experienced, due to agricultural expansion, logging, mining, fuelwood collection, and other factors.** The heavy reliance on woodfuel in the region has resulted in the unsustainable harvesting and consumption of forest resources, which will have significant impacts

on local communities and future income from the forest sector. The loss of forest land to agriculture expansion is related to the growth of industrial plantations and farms that provide food for growing urban centres, and the expansion of small-holder agriculture. Global consumption and regional population growth have also contributed to dramatically increased deforestation.

- **Africa has also not sufficiently developed value-added industries along forest value chains and continues to rely on the trade in primary products of forest resources.** Development in high value-added industries has been limited by infrastructure, technology development, and skills availability in the region. However, this is not true for all countries in the region, as some are using policies to stimulate the development of value-added industries. For example, the Economic and Monetary Community of Central Africa, an organization made up of Cameroon, the Central African Republic, Chad, Equatorial Guinea, Gabon, and the Republic of the Congo, is moving towards a ban on the export of unprocessed roundwood by 2023 (Association Technique Internationale des Bois Tropicaux, 2021a). Gabon, which has already implemented this measure to improve value-addition for wood exports, is a model for the implementation of these policies.
- **There is also a strong presence of informal markets** consisting of small actors and fragmented players. Small and medium forest enterprises provide significant direct income and employment but can be constrained by limited business acumen, as well as poor access to finance and markets. However, these informal value chains can be organized and present a significant source of employment for local communities (Bromhead, 2012).
- **The forest-based circular economy is underdeveloped.** Processing forest resources still produces valuable "waste" material that could be repurposed to both reduce wastage and create other opportunities in the form of jobs, products, and services. However, Africa's circular economy is underdeveloped mainly because of limited circularity in the formal economy, despite the global market being valued at USD 4.5 billion (World Business Council for Sustainable Development, 2017).

To ensure that Africa's forests are developed, protected, and maintained adequately, country-level strategies must be grounded in a shared continental commitment. For the continent to fully tap into the forest-based bioeconomy opportunities, a strategy is needed to determine how natural forests are to be maintained and developed. Also, the role of sustainable plantations must be strengthened to meet future supply needs in forest products. Developing a continental and shared vision of the image Africa wishes to achieve in the area of bioeconomy, the key bottlenecks hindering growth and the key levers will prove to be a useful tool to rally countries, the private sector, and technical and financial partners around a shared vision, and act as a roadmap for implementation. Additionally, such a strategy will serve as a benchmark for countries to customize and contextualize a continental vision to enable the necessary policy changes and the strategic investments to grow their forest-based bioeconomies.

However, countries will need to overcome a range of challenges, including enforcing forest conservation and sustainable use while making the necessary compromises with neighboring communities, finding cost-effective ways to harvest, and importing endemic species to boost production. To grow their bioeconomy and leapfrog towards a

steadily, rapidly growing sector, countries will need to overcome several key challenges. Forests will need to be conserved or sustainably managed to refrain from destruction or degradation through human intervention. This will require strong political will and strict policy implementation and adherence, as well as education on the importance of forest conservation – especially among communities living in the peripheries of forests (Conserve Energy Future, 2021). However, this will require compromises in the case of forests that have social, economic, and cultural importance for neighboring communities. Countries will need to respectfully and considerately monitor human intervention on the peripheries of these forests. Another key challenge will be to ensure that forest products are harvested sustainably from natural forests. The reality of natural forests is that harvesting is particularly challenging, due to irregularities in tree spacing, and this in turn affects the quality of trees (Forestry Focus, n.d.). Lastly, there is a need for new plantations and perhaps the introduction of new endemic species – that is, those not naturally found in that particular area – specifically as an economic strategy to boost the forest economy. Forest production can be increased by establishing new forest plantations adapted to the local conditions and with quick-growing species (FAO, n.d.a) with proper management practices in place (Chamshama and Nwonwu, 2004).

Forest-based products and services

Wood products in Africa create most of their value through primary production activities, and the region is also a net importer of forest products. As of 2011, the formal wood harvesting and processing sector in Africa was estimated to generate USD 17 billion per year, of which just under two-thirds was from forestry and logging activities, and about a third was from processing activities (Grieg-Gran *et al.*, 2015). The value created in processing activities is largely attributed to the production of wood charcoal, sawnwood, and paper and paperboard. Overall, due to limited processing capacities, Africa is a net importer of major wood products, the largest category of net imported goods being paper and paperboards and wood-based panels, valued at USD 4.1 billion and USD 1.1 billion respectively, while the greatest net export value is for roundwood, valued at USD 1.8 billion. This net import value is largely driven by imports by northern Africa,[2] mostly of sawnwood and paper and paperboard products (FAO, n.d.a). As seen in Table 1, most roundwood in Africa is produced in eastern and western Africa, while high-import products like paper and paperboard and wood-based panels are largely produced in southern Africa, mostly in South Africa.

[2] Specifically, Algeria, Egypt, Libya, Morocco, the Sudan and Tunisia.

Table 1. Production of wood products in Africa

	Unit (millions)	Africa	Eastern Africa	Western Africa	Central Africa	Northern Africa	Southern Africa
Roundwood	m^3	784	336	226	133	56	36
Wood charcoal	tonnes	35	15	11	4	3	0.7
Sawnwood	m^3	12	2	4	3	0.2	2
Wood chips, particles and residues	m^3	3	0.3	0.7	0	0.5	2
Paper and paperboard	tonnes	3	0.2	0	0	1	2
Wood-based panels	m^3	3	0.4	0.7	0.1	0.3	2
Wood pulp	tonnes	2	0.6	0	0	0.1	2
Recovered paper	tonnes	2	0.1	0.1	0	0.7	1

Notes: This table does not consider the sustainability of harvesting practices, as this type of data is neither collected nor reported.
Source: FAO. 2021. FAOSTAT: Forestry Production and Trade. [Accessed on 2021]. https://www.fao.org/faostat/en/#data/FO. Licence: CC-BY-4.0.

Woodfuel plays a significant role in the African energy mix. Wood energy accounts for about 44 percent of the total primary energy supply in the region, and an estimated 63 percent of the population is reliant on woodfuel for cooking (World Bioenergy Association, 2020; IEA, 2019; FAO, 2022a; WHO, 2021). About 90 percent of the wood harvested in Africa is used as woodfuel (FAO, 2020b). Comparatively, globally, only 45 percent of roundwood in production is used as woodfuel, as against 61 percent and 44 percent for Asia and South America respectively. This limited availability of industrial wood, which excludes woodfuel, contributes to the limited value-added activities on the continent (FAO, n.d.a).

Within NWFPs, plant-based foods and biomass, specifically for medicines, aromatics and colorants, dominate the formal African market. Globally, and regionally in Africa, little data is available on the quantity and value of trade of NWFPs, though it has been estimated that total income from informal production of NWFPs amounts to USD 88 billion, most of which is attributable to plant-based NWFPs (FAO, 2014). Regional trade and the local consumption of NWFPs are significant for the trade of these products in the region, and in many cases, these local and regional markets dwarf those for exported products (Agustino *et al.*, 2011). Within the formal sector, edible plants alone in Africa account for an estimated 45 percent of the commercial market production value of NWFPs. Meanwhile, medicinal and aromatic plant biomass, as well as raw materials for colorants, account for an estimated 20 percent and 19 percent of the commercial market production value of NWFPs respectively (FAO, 2020b). Table 2 provides an overview of important NWFPs in Africa.

Table 2. Important NWFPs in Africa

	Eastern Africa (incl insular)	Western Africa	Central Africa	Northern Africa	Southern Africa
Animal products	• Honey and beeswax • Living animals *(e.g. birds and reptiles)* • Bushmeat	• Honey • Bushmeat • Living anaimals	• Bushmeat • Living animals		• Bushmeat • Insects, caterpillars and termites
Food	• Fruits • Forage • Wild coffee *(coffea vaughanii)*	• Edible plants *(shea tree and African locust bean, cola, shea butter, oil palm)* • Medicinal plants • Forage	• Fruits and nuts • Edible plants *(leaves, mushrooms and legumes)*	• Honey • Fruits	• Nuts and fruits • Other edible plants *(leaves, tubers, roots, nuts, mushrooms)*
Biomaterial	• Fodder plants • Medicinal plants • Ornamental plants *(Christmas trees, orchids)* • Aromatics • Bamboo	• Rattan • Construction material	• Medicinal plants • Rattan • Ornamental plants • Construction material	• Medicinal plants • Aromatic plants • Fodder • Alfa grass • Cork	• Medicinal plants *(devil's claw, origanum, sage, cape aloe, liquorice, kiaat/wild teak, among others)* • Ornamental plants *(leatherleaf fern)*
Extracts	• Exudates *(gum arabic, myrrh, opopanax, gum karaya and olibanum)* • Shea butter	• Gum		• Essential oils • Gums	
Biochemical	• Tannin • Dyes *(henna)*	• Tannins			

Source: Agustino, S., Mataya, B., Senelwa, K. & Achigan-Dako, G.E. 2011. Non-wood forest products and services for socio-economic development: a compendium for technical and professional forestry education. Nairobi, African Forest Forum. https://docslib.org/doc/1873734/non-wood-forest-products-and-ser-%20vices-for-socio-economicdevelopment.

However, the NWFPs sector in Africa is also significantly based on informal activities and income generated from animal-based NWFPs. Globally, in 2011, informal sector income (based on production value) from NWFPs activities was about USD 88 billion, most of which (88 percent) came from plant-based NWFPs. Africa accounted for USD 5.3 billion (6 percent) of global informal income. And in contrast to the formal sector, the informal activities in the NWFPs sector in Africa were largely attributed to animal-based NWFPs, valued at USD 3.2 billion (60 percent of the total Africa value) (FAO, 2014). Wild protein is an important part of local diets in some areas of the region, such as the Congo Basin, where bushmeat is eaten in both urban and rural settings. In the Congo Basin, the commercial trade in bushmeat is a significant driver for the increasing extraction of protein from forest resources. Bushmeat is traded through both formal and informal channels and can also be cheaper than alternative meat sources (Nasi, Taber and Van Vliet, 2011). Africa's informal market in plant-based NWFPs accounts for 39 percent of total income from the informal production of NWFPs in the region (FAO, 2014).

Although ecotourism contributes significantly to local economies and conservation efforts in the region, the sector has been severely impacted by the COVID-19 pandemic. Africa's wildlife and biodiversity have led to an economically and socially significant tourism sector. Around 80 percent of tourism in the region is for wildlife, with the top nature-based tourism destinations in the region being located in eastern Africa and southern Africa. Africa's 8 400 protected areas produce USD 48 billion in revenue and provide 40 percent more full-time employment than agriculture as well as greater opportunities for women (UNEP, 2019). Wildlife-based tourism alone generates over USD 29 billion annually and employs 3.6 million people (Lindsey *et al.*, 2020). However, the COVID-19 pandemic has resulted in a 49.2 percent decrease in the GDP contribution of travel and tourism in the region, as well as a 29 percent decrease in employment in the sector (World Travel and Tourism Council, 2021a). The World Tourism Organization projected that globally, international arrivals will return to 2019 levels in about two and a half to four years (Spenceley, 2021).

Forest areas can provide **regulating, provisioning as well as cultural and social services** to communities:

- **Regulating services**: maintain the quality of air, soil, water, and other processes in forest ecosystems. These services include ecosystem functions such as carbon sequestration and storage, moderation of extreme events, wastewater treatment, erosion prevention and maintenance of soil fertility, pollination, biological control, and regulation of water flow.
- **Provisioning services**: provide goods for consumption or trade for communities such as hunting and harvesting of wood and NWFPs. This consists of food, raw materials such as wood, natural gas and oils, water, and medicinal materials.
- **Cultural and social services**: provide non-material benefits for communities, such as aesthetic inspiration and spiritual experience, traditional foods and medicines, music and dance, and the interconnected relationships between culture and environment and place. This includes recreation and mental and physical health services and tourism (FAO, n.d.b).

Specifically concerning regulating services, payment for ecosystem services (PES) has gained traction in the region, though the activities conducted are not without social and legal constraints. PES schemes are mechanisms by which landowners, farmers, or local communities are paid to conduct environmental services on their land for the beneficiaries of these services. These schemes are relatively nascent in the region but form part of mitigation efforts that have been of increasing interest as a response to climate change. PES schemes consist of forest conservation, watershed protection, agroforestry, and carbon sequestration, and have demonstrated social and economic benefits for local communities (Rosa and Martius, 2021). In eastern Africa, these services mainly occur on forests and grassland savannahs, focusing on payments for smallholder farmers and pastoralists (Tetra Tech and Land Trees and Sustainability Africa, 2018). However, unclear land tenure and limited enabling policy are key challenges to sustainable and equitable tourism and PES schemes in Africa.

Other regulating services in the region include forest-based and agroforestry-based carbon markets. Africa accounts for 17 percent of global carbon stocks from forest vegetation and 15 percent of the global volume traded in the voluntary carbon market (Forest Trends Ecosystem Marketplace, 2019). Indeed, Africa has a vast potential role in global carbon markets, with the region accounting for 28 percent of the agroforestry tree cover area in the world, second only to Asia (FAO, 2020b). However, voluntary and compliance markets are not yet harmonized in terms of price, value, or verification, and will require new and existing intermediaries to cooperate, especially in view of the developmental trajectory of most African countries and the ratio of informal to formal market activity.

Impact of the COVID-19 pandemic

The rise of the COVID-19 pandemic and other zoonotic diseases can be directly linked to deforestation and a fractured relationship between people and nature. The fracturing relationship between humans and the natural world is depicted in the increase in zoonotic diseases. As a result of extensive forest land conversion, about

70 percent of forests globally are now within one kilometer of a forest edge and are exposed to further fragmentation. Infrastructure development, including new roads and railways, the transformation of natural areas to commercial and retail use, and other drivers of land-use change also contribute to the destruction and fragmentation of wildlife habitats and increase human–wildlife contact and conflict. Additionally, rising urbanization, especially when unplanned and with poor infrastructure, is creating novel and diverse contacts among nature and people, often providing favourable grounds for the emergence of infectious diseases, including zoonoses (UNEP and ILPRI, 2020). In fact, approximately three to four new infectious diseases emerge each year, most of which originate from wildlife. Over the last 30 years, approximately 60–70 percent of the new diseases that emerged in humans had a zoonotic origin. Research has linked the Ebola outbreaks over the past decade to increased deforestation and the Severe Acute Respiratory Syndrome epidemic to human contact with infected palm civets and raccoon dogs due to unsustainable wildlife consumption patterns.The COVID-19 pandemic, linked to a disease prevalent in horseshoe bats, is one of the latest examples of this type of spillover and has demonstrated the grave consequences of unregulated human–wildlife interactions.

The COVID-19 pandemic has had significant impact on the African economy, including the continent's forest-based bioeconomy. It is the service economic sector, specifically tourism, that has been among the sectors most highly financially impacted by the pandemic. Precautionary measures such as lockdowns, social distancing mandates, and border and mobility restrictions created an economic shock for ecotourism across Africa. The sectors of the forest-based bioeconomy have experienced job and income losses, which have in turn impacted the livelihoods of people dependent on forest resources. Forest areas were also made vulnerable by the limited availability of human capital for forest conservation and monitoring. In areas like the southern African Development Community, small and medium-sized enterprises and the informal sector, which play critical roles in the forest-based bioeconomy, were found to be more impacted than the formal sector by the pandemic (SADC, 2020). In other subregions, local bioeconomies based on subsistence use and local trade of forest products, and smallholder agriculture, were able to sustain regions cut off from the global economy.

The pandemic has caused disruptions in demand, export prices, and supply chains for wood and NWFPs. For example, a fall in cocoa export prices and a decrease in demand threatened the livelihoods of farmers in western Africa, while demand for timber from Africa's traditional markets in Europe and the United States of America also fell. Processing was disrupted across the bioeconomy, as well as other forest activities, while in Ghana nursery operations and reforestation were among the forest-based activities that were most highly impacted. In some cases, however, the COVID-19 pandemic led to increased demand for medicinal plants and functional foods.

In several African countries, the forest sector did not benefit from stimulus packages issued during recovery efforts because, except for countries such as Gabon and South Africa, the forest sector is not seen as a priority. Foreign direct investment was also adversely impacted by the pandemic and was expected to contract by 25–40 percent in 2020. Development funding that was earmarked for other development areas has been directed toward combating the pandemic.

Illegal harvesting of timber and NWFPs in Africa have increased because of the resultant decrease in public sector monitoring of forests. Populations that have had their incomes and livelihoods negatively impacted in the region have engaged in illegal activities such as poaching and illegal timber production (Attah, 2021).

Opportunities in the forest-based bioeconomy

As seen in Figure 4, the major products and services that stem from forest resources are linked to six economic sectors, namely: construction, manufacturing, services, agriculture, energy, and health. The 2050 projections for the market value and the employment for the opportunities below are estimations calculated using the methodology and modelling assumptions described in Annex A.

Construction

There is an opportunity to increase the use of sustainable wood products in the construction sector in Africa. Wood is used for both formal and informal construction in Africa. Forests and woodlands are significant contributors of wood and non-wood materials, such as leaves and adhesives, for construction in the region. The built environment in the region is responsible for 56 percent of energy use, 25–40 percent of all waste generation, and 5 percent of all water consumption (ESI Africa, 2019). However, modern wooden construction materials (such as the use of cross-laminated timber) that generate reduced emissions when compared to concrete and steel, enjoy limited use in the region (Rosa and Martius, 2021). There is an opportunity to decrease GHG emissions and create a more sustainable construction sector on the continent by substituting cement, iron, and steel with wooden building materials.

Africa's population is expected to significantly rise in the coming years, increasing the region's need for housing and construction materials. With the population in Africa expected to double by 2050 (The Economist, 2020), an estimated 80 percent of the buildings needed by that time have not yet been constructed (World Green Building Council, 2020). Meanwhile, an estimated 50 percent of the urban population in Africa lives in slums. However, improved housing with sufficient durability has been on the rise in sub-Saharan Africa. The number of adequately constructed houses in the region was 13 percent in 2015, up from 11 percent in 2000 (McVeigh, 2019). If this trend continues, the market for durable construction materials is likely to also rise.

This opportunity also could create carbon sinks through forest plantations created on agricultural, degraded, or open lands for continued wood supply and has additional operational benefits for the construction sector. For example, the use of cross-laminated timber also allows for advantages in site management, such as shorter construction periods, less wastage, smaller on-site labour forces, and less labour-intensive construction, creating opportunities for the increased involvement of women in the sector. Africa can invest in the sustainable production and bioprocessing of wood-based construction materials to fill this construction deficit.

There is a need to develop both the forest plantation area and wood processing capabilities in the region to unlock this opportunity. Other value chain enablers that

would need to be addressed include the capacity for seedlings to meet this demand and regulatory barriers to sustainably sourcing from natural forests. The wood deficit faced by Africa will be a significant challenge in realizing this opportunity. There is also a limited supply of industrial wood (essential for both the wood manufacturing and construction opportunities identified) used for processing because of the high demand for woodfuel in Africa and the amount of roundwood exported. Over the period 2010–2015, investments into establishing plantations and manufacturing in Africa were 8–10 times lower than those in Asia and the Pacific and Latin America. At the current trajectory, to meet Africa's growth in demand for wood products, an estimated 300 000 additional hectares of plantation area would need to be established a year. Depending on the type of plantation developed, this would require an investment of up to USD 1.7 billion (Indufor Oy and Criterion Africa Partners, 2017). Establishing mechanisms to develop these plantations, and to harvest sustainably from natural forests, would be essential in realizing this opportunity and overcoming the supply barrier of wood in Africa. These mechanisms must be tailored to the various subregions, considering the specific environmental and socioeconomic contexts.

The increased use of wood building materials has the potential to contribute up to an estimated USD 83 billion towards Africa's bioeconomy by 2050. This could be achieved via the production and primary processing of wood to meet the expected demand for housing in 2050. An estimated 25 million jobs could be created through the additional plantations needed to build the supply of wood required for this opportunity, and for the subsequent processing needed to develop the building materials.[3]

Manufacturing

The opportunity for increased industrialization and beneficiation has long been recognized in Africa and also holds for forest resources. This opportunity reveals the uncaptured potential for the processing of wood products in the region. Although Africa and Europe each both produce about 20 percent of the world's roundwood, Europe contributes 49 percent of global export value, while Africa only contributes 2 percent. This is partly due to the high domestic demand for wood in Africa and the high component of roundwood exported, instead of other value-added wood products.

Presently there is limited bioprocessing and biorefinery of forest-based wood and non-wood raw materials in the region largely due to the lack of technology, skills, and capital required for specialized high-value-added bioprocessing activities. Africa is the only global region where forestry and logging (primary activities) make a greater contribution than processing activities in the wood harvesting and processing sector (Grieg-Gran *et al.*, 2015). There is a low capacity for wood processing in the region, and a low supply of industrial wood to meet the demand for processed wood products. There is also a low state of development and investment in technology and skills of existing wood processing. Table 3 provides an overview of wood processing gross value-add in Africa.

Bioprocessing also presents an opportunity for the end-of-life use of by-products from primary sector forest activities, in support of a circular bioeconomy. For example, in Ghana, a study conducted on the potential of plantain residues as a resource for industrial raw materials (fibre) revealed that the necessary structures exist to establish a

[3] Dalberg Catalyst estimate.

sustainable plantain-based value web (a connection between biomass raw materials and by-product value chains) (Callo-Concha *et al.*, 2020).

Table 3. Wood processing gross value-add in Africa

	Eastern Africa	Western Africa	Central Africa	Northern Africa	Southern Africa	Total Africa
Roundwood production (USD million)	2 713	3 864	988	346	2 917	**10 828**
Wood processing (USD million)	97	527	693	447	1 254	**3 018**
Pulp and paper (USD million)	167	146.5	71	710	1 624	**2 719**

Source: FAO. 2014. Contribution of the forestry sector to national economies, 1990-2011, by A. Lebedys and Y. Li. Forest Finance Working Paper FSFM/ACC/09. FAO, Rome.

Significant investment will be required in increasing the necessary wood supply, access to markets, and technology and skills capacity to pursue this opportunity. Similar to the opportunity identified in the construction sector, the limited supply of industrial wood in the Africa region will be a constraint to meeting the demands of regional populations. Micro-businesses also face limited access to finance to grow their operations and gain access to larger markets, as well as limited marketing capacity to extend their reach. These organizations have also found it challenging to remain compliant in a legal environment where compliance requirements are changing (Charpentier, 2018).

The wood processing sector could contribute up to an estimated USD 572 billion to the continent's bioeconomy by 2050. This economic activity could also create an estimated 29 million jobs by the same period. This opportunity would anchor on transitioning the sector towards increased value-add through secondary processing activities.[4]

Services

A promising future for ecotourism in Africa can be driven by the growth of domestic tourism in the region. Restricted domestic and international travel has decreased revenues, and this could impact tourism funding for the conservation of these areas in subsequent years. South Africa, whose export value of tourism is second only to mining, was losing South African Rand 336 million a day (equivalent to USD 20 million in 2020) in tourism-related spending to lockdown restrictions (Global Vision International, 2020). Domestic tourism accounted for 55 percent of travel and tourism in Africa in 2019 but jumped to 68 percent in 2020 due to restrictions on international travel. Countries in the region have realized the importance of domestic tourism in developing a resilient tourism sector that protects against international shocks. However, even with this recent state, Africa's level of domestic tourism is significantly less than the global average of 73 percent (Monnier, 2021). With a growing middle class, and the recent launch of the African Continental Free Trade Area, travel and tourism hold potential for the future of the region's bioeconomy.

There is also an opportunity for nature-based solutions (NBS), including forest solutions such as Reducing Emissions from Deforestation and Forest Degradation (REDD+) in Africa for their mitigation and adaptation action while ensuring relevant social and environmental safeguards. Despite Africa being one of the early adopters of the United Nations Framework Convention on Climate Change (UNFCCC) framework on REDD+, carbon finance disbursement is merely nascent in the region, largely due to large capital

[4] Dalberg Catalyst estimate.

investment requirements and unclear land rights and regulations. As of today, only 1 percent of total result-based finance has been channeled to the region (i.e. Mozambique, Ghana and Gabon) (Author's estimate based on UNFCCC, n.d.b; Forest Carbon Partnership, n.d.b.;. Central African Forest Initiative, n.d.). On the other side, the voluntary carbon market has significant potential, should concerns on environmental integrity, leakage, permanence and the respect of social and environmental safeguards be addressed. In 2022, the Democratic Republic of Congo, Kenya and Zimbabwe were in the top ten-country issuance in NBS in the world (Climate Focus, 2022). This opportunity reveals the potential for Africa to use NBS approaches, including REDD+, to protect forest resources and generate income through carbon transactions.

While the tourism sector and voluntary carbon markets provide opportunities, both also face challenges. With the introduction of the COVID-19 pandemic in 2020, it is still uncertain what tourism will look like in the near future. The scaling of NBS approaches, including carbon projects, across the region has been rather slow because of a lag in developing an appropriate enabling environment. Furthermore, technical skills gaps, unclear tenure, and property rights still create barriers to this opportunity.

Ecotourism and carbon finance, including result-based finance and voluntary carbon market initiatives, have the potential to contribute value to the African bioeconomy.[5] The growth of ecotourism could be driven by an increase in the contribution of domestic tourism to 62 percent of tourism spending. The opportunity for ecotourism could create value within a model of estimation of USD 670–740 billion and generate an estimated additional 45–50 million direct and indirect jobs. Through the implementation of REDD+ activities in the region, there is the potential to create some 13 000 jobs for local community members and avoid the loss of some 314 million $MtCO_2e$ annually through avoided deforestation.[6]

Agriculture

The opportunity for further upscaling of agroforestry in Africa has the potential to improve the socioeconomic and environmental conditions of smallholder farmers. Agroforestry's potential to improve livelihood resilience, provide ecosystem services and increase food security has been recognized in both developing and developed countries. However, the performance of agroforestry when compared to monoculture agricultural systems is limited and scattered or contingent on specified use-cases. Generally, agroforestry is a longer-term investment than conventional agriculture and requires longer profit forecasts and planning. However, because of the composition of available data and the lack of scaled implementation of agroforestry in comparative regions, the focus would be on non-income benefits, which would still have significant impact in Africa.

Tree products have garnered interest in the region through agroforestry efforts. Agroforestry has aroused interest in the region as a means to improve rural livelihoods for smallholder farmer households by diversifying incomes and providing greater ecological resilience. The trade of agroforestry tree products often has access to domestic and informal markets, while mainly requiring household labour for the additional income

[5] Dalberg Catalyst estimate.
[6] Dalberg Catalyst estimate.

and non-income benefits. The retailers and beneficiaries of the trading of agroforestry tree products are also often women (Leakey *et al.*, 2006). Agroforestry can also supply farmers with other revenue streams, specifically trade in tree crops such as fruits and fodder, timber, and carbon. As mentioned, agroforestry's main attractiveness stems from non-income benefits, such as curbing the loss of natural forests by improving land productivity and tree coverage, as well as improving food security, food diversity, and the soil quality of farmland for smallholder farmers. The potential for the upscaling and commercialization of agroforestry tree products is key to the realization of this market in Africa but would require greater investment in domestic and informal markets, including the establishment of an enabling environment for agroforestry through policies supporting agroforestry, institutional mechanisms, and incentives or subsidies for planting trees on farms, extension services and the creation of markets, infrastructure and producer organizations to increase market access (Ofori *et al.*, 2014).

Additionally, agroforestry systems can support ecosystem restoration and landscape recovery by combating desertification and land degradation, and easing the pressure on natural forest resources that are often subject to unregulated wild harvesting. Trees from these systems provide erosion control, improve water filtration, and can act as windbreaks (World Agroforestry, 2021). Scaling agroforestry could also contribute to other development initiatives on the continent, such as the Great Green Wall, which aims to grow 8 000 km of trees across Africa (The Great Green Wall, 2021).

The domestication of indigenous tree species also has the potential to increase income and food security and serve as a complement to wild harvests. The domestication of indigenous fruit trees (the process of bringing wild plants under management and cultivation [Thomson *et al.*, 2001]) would benefit the availability of some NWFPs. While there still is limited adoption of some fruits as profitable crops, wild harvesting of fruits is a promising and profitable activity in the region. For example, the potential market for baobab (*Adansonia digitata*) globally has been valued at USD 980 million, while the demand for baobab powder alone is expected to grow to USD 8.5 billion in 2027 in the European Union. However, the World Agroforestry Centre has worked in partnership with NGOs, farmer associations, and governments in Africa to promote the domestication and commercialization of indigenous fruit trees on the continent through agroforestry (Africa Forest Forum, 2019). Further research and action are required to promote the sustainable management of NWFPs such as baobab, for which there are as yet no commercialized plantations in Africa (Centre for the Promotion of Imports, 2021; Omotayo and Aremu, 2020).

There is also an opportunity to improve the production of fruits and tree nuts already being cultivated in the region where market linkages are clearer. Edible fruits and nuts have shown higher-than-average growth in fruits and tree-nut production between 2015 and 2019 (FAO, n.d.a). Globally, fruit and tree-nut markets are expected to grow, and there is room to grow the cultivation and commercialization of tree crops in Africa. This opportunity reveals the potential to improve the yield of fruit production on land that is already being cultivated to meet benchmarks such as Brazil and to increase the overall production of tree nuts for global markets.

Africa is not a major world fruit exporter when compared to other tropical regions

like South America. However, of the fruit exported, the vast majority goes to markets outside of the region. The largest importer of African fruits is the European Union (40 percent) (BizVibe, n.d.). While there are multiple smallholder and other farms producing fruit for the domestic markets, overall tree crop farming in Africa is distinguished from other regions by its strong reliance on global markets. The competitive pressures of these markets have restricted efficient market links for tree crop farming systems to western Africa but these are in turn threatened by external pressures (Gockowski, 2019). Africa produces similar tropical fruits to South America – one of the largest global suppliers – creating an opportunity to improve the region's market share of high-demand fruits such as bananas, citrus fruits, and apples. The region also produces 7 percent of the world's tree nuts; 88 percent of which are cashew nuts that make up about half of the world's supply. Africa also only consumes 7 percent of the world's tree nuts; comparatively, mature tree-nut markets like North America produce 40 percent and consume 23 percent of the world's tree nuts (INC, n.d.). Additionally, Africa also has the potential for additional value-add for fruits and tree nuts. For example, only 15 percent of the continent's nuts are deshelled in Africa, despite secondary processing adding up to 2.5 times the value of these products (United Nations Conference on Trade and Development, 2021).

Domestic consumption of fruits and nuts is also expected to increase. Per capita consumption of fruits has been on the increase in Africa (Indexbox, 2021). However, daily fruit and vegetable intake per capita remains well below World Health Organization recommendations, although in tropical forest zones this is not the case for rural communities, due to the consumption of wild foods (Mensah *et al.*, 2021). Consumption trends of fruits in high-income countries have been stagnant or declining, but as African economies grow and the middle class expands in the region, it is expected that domestic consumption of fruits and nuts will also increase, while traditional foods remain popular in villages and urban centres, and across all classes.

However, the opportunities within agriculture face certain market-related challenges and concerns. Although domestic and regional markets are well established and significant for agroforestry or wild-collected products, the quantitative potential of the opportunity for agroforestry and related products remains unclear. While there is a need to upscale agroforestry, a better understanding of market demand for agroforestry products, as well as related investment costs, is also required. Without the scaling of successful models, it would be difficult to fully realize the full potential of agroforestry in Africa as it faces barriers such as the limited domestication of indigenous tree crops, inadequate agronomic practices, and the informality of smallholder trading markets (Place *et al.*, 2012). The cultivation and commercialization of fruits and nuts face similar problems, but with better-established market linkages, the market challenges faced would revolve around improving the harvesting and post-harvesting route to market capacity. Investment in Africa's agricultural sector includes the need for additional investments to build an enabling environment, such as financing for production and the route to market. This could include investment into inputs such as fertilizer and quality seeds, cold storage, and basic infrastructure such as roads, ports, and electricity (Goedde, Ooko-Ombaka and Pais, 2019).

The production of fruits and nuts in Africa has the potential to grow to an estimated

value of USD 200 million in 2050. Africa could be able to better meet local demand for fruits and nuts and promote export for international markets by growing the production area and improving agronomic practices. This opportunity also has the potential to create 19 million full-time equivalent (FTE) employees.[7]

Energy

Africa is highly dependent on woodfuel and faces a deficit in modern energy supply, creating an opportunity for modern use of bioenergy in the region. This regional demand for wood-based energy has contributed to forest degradation – and in some cases deforestation – and piqued interest in bioenergy overall (including wood energy). In 2018, woodfuel accounted for more than 40 percent of total primary energy supply on the continent. The region, however, is starting to transition to modern renewable energy sources such as hydropower, wind, and solar power to meet increasing demand. Renewable energy has the potential to meet 22 percent of Africa's total final energy consumption by 2030 (IRENA, 2015). Bioenergy feedstock can be derived from natural forests, energy crop plantations, or forest-based value chain systems (where energy is produced from forest residues) (Nyika *et al.*, 2020). Bioenergy from plantations is renewable and can be carbon neutral if forests are allowed to regrow and be circular where forest residue feedstock is used sustainably.

There is an opportunity to address the energy deficit by more effectively recovering forest and wood residue for bioenergy in the region. Forest residues have the potential for the circular processing of recovered wood that would increase the productivity of wood harvested. As 90 percent of the roundwood produced in Africa is used for woodfuel, this opportunity reveals the potential for increasing the recovery of wood from field-based activities and using the additional residues to produce wood-based biofuel such as wood pellets.

Although Africa has the land area to produce energy crops such as palm oil and jatropha, the sector has shown slow development. Jatropha and palm oil are the major biodiesel production feedstocks in the region. However, the production of biodiesel is nascent. Jatropha specifically has garnered interest as a biofuel crop due to its perceived ability to grow in semi-arid regions with low nutrient requirements and little care. The general cost of biodiesel is higher than the cost of petrodiesel, largely driven by the high costs of raw feedstock. The demand for biodiesel products would be driven by the prices of diesel or other petroleum products and the improved sustainability impact of biodiesel. A recent assessment by the World Wide Fund for Nature, in collaboration with Boeing, estimated that sub-Saharan Africa has the potential to supply 30–90 percent of future alternative aviation biofuel demand in 2050 (World Wide Fund for Nature, 2019). However, despite the high interest bioenergy received in Africa because of this potential, the development of the sector has been slow, and high-potential crops like jatropha have yet to yield expected returns (Rosa and Martius, 2021).

[7] Dalberg Catalyst estimate.

However, biofuel opportunities face barriers due to implementation and pose environmental concerns. While energy crop plantations may be renewable, the production of biofuel often requires the use of fossil fuels (Dufey, Vermeulen and Vorley, 2007). There are also concerns that scaling energy crop plantations is a threat to food security, using land that could otherwise be designated for food crops. Despite already being widely grown in some regions of Africa, the practice of creating fires to clear land areas for the production of palm oil could threaten the environment and local communities due to the air pollution produced. A potential barrier to scaling the use of forest residue in Africa would be the mobility limitations for residue collection and transport to processing mills while meeting sufficient economies of scale. There is a crucial prerequisite for the market linkages and physical infrastructure to source and transport feedstock without accumulating unsustainable costs for these biofuel opportunities (Alfano *et al.*, 2016).

By 2050, forest residues in Africa have the potential to generate additional wood energy valued at USD 621 million in the form of wood feedstock. Additionally, the processing of this feedstock could generate some 90 000 jobs.[8]

Health

Although the forest-based health sector has great significant value and potential in Africa, commercialization has been limited. Herbal medicines aggregate to a global multibillion-dollar market, estimated at USD 83 billion in 2019, and expected to reach USD 550 billion by 2030 (InsightSLICE, 2021). Moreover, demand for medicinal and aromatic plants is growing, with a trade value growth of 75 percent, and a volume increase of 22 percent between 2000 and 2020 (Schindler *et al.*, 2022). Some medicinal plants found in sub-Saharan Africa have great value in this global market. For example, the trade of red stinkwood (*Prunus africana* or pygeum) and periwinkle (*Catharanthus roseus*) respectively is valued at USD 200 million and USD 100 million annually. Both are available in the region and are also used as traditional treatments. Between 2011 and 2019, approximately 8.6 million kilograms of pygeum were reported in exports, the majority of which was from wild sources (CITES, n.d.). Europe is estimated to import USD 1 billion of medicinal and aromatic plants from Africa and Asia (Lambert, Ryden and Esikuri, 2005). In 2008, 80 percent of Ghana's medicinal export earnings (USD 12 million) were derived from two multipurpose medicinal plants (*Griffonia simplicifolia* and *Voacanga africana*). However, data from Ghana shows that only a fraction of available medicinal flora is commercialized (Van Andel, Myren and Van Onselen, 2012).

Despite the local and global demand for these products, the use and trade of medicinal plants in Africa is also largely unregulated and informal. The informal way in which these forest products are harvested threatens the secure supply of natural resources. And as the market for herbal medicines has increased over the past few decades in both developing and developed countries, trade has been restricted by the limited supply of some of these products. There is a lack of reliable, quantitative data on the trade of herbal medicines in Africa but plants such as *Acacia senegal* (gum arabic) and *Acacia albida* (medicines) are already cultivated and commercialized in the region. However, although the sector is well developed for selected value chains such as devil's claw and hoodia

[8] Dalberg Catalyst estimate.

in southern Africa, *Prunus africana*, *Voacanga*, yohimbe, cola, *Strophanthus* in central Africa, *Prunus africana* in eastern Africa, and *Griffonia* in western Africa, investment in the commercial opportunity of medicinal plants remained limited due to availability of trade data and resource degradation due to increased harvesting (Lambert, Ryden and Esikuri, 2005).

There is an opportunity to improve the cultivation and commercialization of medicinal plants in Africa. Noting that for example in the larger Asian markets, only about 3.3 percent of medicinal plants are cultivated, while the remaining proportion is derived from wild gathering (Astutik, Pretzsch and Ndzifon Kimengsi, 2019). Globally, some 60–90 percent of medicinal plant species are thought to be collected wild (Schindler *et al.*, 2022).

This opportunity would reveal the potential for combining the use of wild-collected species and cultivating and commercializing the production of selected medicinal plants. India, for example, has aimed to promote the cultivation and export of herbal medicines via the National Medicinal Plants Board. However, the impact of incentives for the cultivation of medicinal plants for production and exports remains unclear.

Africa's biodiversity creates an opportunity for income generated from bioprospecting. Bioprospecting can be defined as "the exploration of biodiversity for commercially valuable genetic and biochemical resources" (Reid *et al.*, 1993). The practice of identifying valuable natural resources has long been in effect on the continent. However, bioprospecting has now developed to include social elements such as protecting the intellectual property rights of Indigenous Peoples and creating mechanisms for benefit sharing to compensate these Indigenous Peoples (Rutert, Dilger and Matsabisa, 2011). Despite the potential value of this subsector in Africa, only a few countries such as South Africa are actively pursuing the economic benefits of this opportunity. The country has developed a strategy that aims to promote the sector, which was only valued at USD 0.1 million in 2013 (Department of Forestry, Fisheries and the Environment, n.d.).

Despite the growing demand for herbal medicines, and the availability of natural resources in Africa, any opportunity in the sector will face significant barriers, including the unclear size of the opportunity and limited trade data, which impacts investment risk, as well as the lack of regulation and informality of current trade, which impacts links to large formal markets.

This study highlights impactful and ready-to-scale opportunities in Africa; construction, wood processing, and tourism represent the most promising opportunities for further analysis. From the opportunities discussed, wood processing, domestic ecotourism, cement and steel building material substitution, and tree crop cultivation and commercialization present high-potential socioeconomic impacts. Additionally, cement and steel building material substitution also entails the ecological benefits that can significantly impact the mitigation of climate change in Africa and meet more Sustainable Development Goals than other high-potential opportunities (see Table 4). Wood processing, domestic ecotourism, and cement and steel building material substitution are ready for deployment and potentially have significant economic, employment, and sustainability impacts. These will be further contextualized and assessed in the next section.

Table 4. Readiness and ecological impact of opportunities identified

Sectors linked to the forest bioeconomy	Opportunity	Readiness for deployment	Ecological impact
Agriculture	Scaling agroforestry for smallholder farmers	Low	• Land restoration, specifically soil quality and erosion management • Increased carbon sequestering because of the additional tree cover
	Tree crop cultivation and commercialization	High	• Increased carbon sequestering because of the additional tree cover
	Gathering of NWFPs	Medium	• Sustainable management and equitable use of wild plant and wild animal resources for nutrition-sensitive and biodiversity-friendly value chains
Energy	Forest residue biofuel (circular opportunity)	High	• Increased access to renewable energy, and reducing the use and reliance on fossil fuels • Circular opportunity through the use of wood processing waste or by-products
Construction	Cement and steel building material substitution	Medium	• Reduced GHG emissions for the construction sector • Potential for increased carbon sequestering if additional wood used for building materials is sourced from new plantations developed to meet the increased demand
Health	Bioprospecting	Low	• If valuable forest-based materials are found through research and development, it could lead to the protection of forest species
	Collection, cultivation and commercialization of medicinal plants	Medium	• Sustainable management and equitable use of wild plant resources; development of nutrition-sensitive and biodiversity-friendly wild plant-based value chains, including medicinal plants • Conservation of traditional and sustainable food systems of Indigenous and Local Peoples Communities (ILPLCs) that depend upon and enhance biological and cultural diversity
Services	Carbon markets	High	• Forest area conservation against deforestation and degradation • Increased carbon sequestering by preventing deforestation through REDD+ activities
	Domestic ecotourism	High	• Income generated towards the protection of forest land area that tourism activities occur on
Manufacturing	Cross-sectoral wood processing	High	• Should the additional demand for wood be sourced from plantations, there is an increase in carbon sequestering

Notes: Dalberg Catalyst analysis, 2021. Readiness for deployment refers to: Low – opportunity is in early implementation globally and regionally or unclear; Medium – examples of the successfully scaled opportunity exist; or High – wildly accepted mechanism for income, employment and sustainability for the forest bioeconomy.

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5. The case for Africa's forest-based bioeconomy opportunities

Cement and steel building material substitution in the United Republic of Tanzania

Introduction

There has been an expected rise in construction in the United Republic of Tanzania, driven by the demand for housing for a growing population. By 2050, the population of the United Republic of Tanzania is expected to reach 129.4 million from 59.7 million in 2020 (Statista, 2021). While the urban population in the country has grown by a CAGR of 5.4 percent between 2011 and 2020, the year-on-year growth rate has been decreasing. An estimated 58 percent of the population is projected to be living in urban areas by 2050 – an estimated increase from 21 million to 76 million. Urbanization and migration are also expected to contribute to this urban population increase. Migration from Burundi to the United Republic of Tanzania is one of the larger migration corridors in Africa, and the country receives intraregional migration from Uganda and Kenya driven by the United Republic of Tanzania's demand for high-skill labour (United Nations Conference on Trade and Development, 2018). The need for housing in the country is exasperated by the housing deficit present in the United Republic of Tanzania. The proportion of the urban population living in slums has been decreasing (40 percent), but as of 2017, no large-scale national social housing programme has been devised to address the housing deficit (Held *et al.*, 2017; World Bank Group, n.d.).

The demand for wood products in the United Republic of Tanzania is expected to continue driving the construction sector. The sector is the largest consumer of roundwood and processed wood products and accounted for 62 percent of industrial wood consumed in 2010. It consumes significant quantities of eucalyptus posts, sawnwood, and wood-based panels such as particle board, fiberboard, and plywood for temporary and permanent use. However, the lack of compliance with regulations and standards in the sector has resulted in poor-quality products reaching the market. The forest sector in the region is dominated by informal enterprises, and even those that are formalized often do not comply with regulations (Held *et al.*, 2017).

The majority of timber used in construction in the country is from plantations, whereas natural forest wood is predominately used for the charcoal industry. There are 553 000 ha of plantation forest area in the United Republic of Tanzania, 65 percent and 20 percent of which are designated for the production of pine and eucalyptus respectively, both being commonly used in construction (FAO, 2020b). However, the plantation forest area has shown little to no growth in recent years. The state is the largest plantation owner in the country (mostly producing softwood designated for construction), but most harvesting is done by the private sector. Although there are also small-scale plantations in the country, these farmers have limited access to markets (Ledger, 2017).

The construction sector is also a major consumer of secondary processing products such as carpentry, flooring, windows, and doors. However, only about 2 percent of gross value-add in the wood sector in the country is devoted to wood processing, while 97.5 percent is devoted to roundwood production (FAO, 2014). Although the use of engineered wood products like cross-laminated timber is not commonplace in the construction market, there have been indications of a willingness to try these products among contractors and architects. Sawmills make up the majority of the processing sector, accounting for 70 percent of processing capacity, but value-added sawnwood (such as treated wood) is often imported.

The case for cement and steel building material substitution in the United Republic of Tanzania

Opportunities exist to implement the substitution of cement, steel, and iron in the construction sector for wood products as the country's urban population grows. As most large-scale projects in the region are in urban areas, the number of multi-storey buildings (which are more likely to use cement in construction) in urban areas is increasing. However, to take advantage of this opportunity, wood supply, wood processing, and regulation and compliance in the forest sector will need to be supported.

Figure 8. Spotlight 1 – BuildX

Spotlight:	**BuildX**, a Kenyan design and construction contractor
BuildX aims to build smart and climate-smart buildings. The company also aims to engage unemployed youth and women in their projects. The company has three impact areas: **Climate** – Using sustainable local building materials with minimal carbon emissions **Well-being** – Designing spaces that promote health, dignity, and core environmental comfort factors **Women** – Prioritizing labour for local women and youth, and supporting skills development for these employees	One of BuildX's projects is the Circular Cooperative Affordable Housing Project, which aims to move the urban residential construction market away from high carbon and wasteful methods. The company has identified a number of risks and challenges to the implantation of this project. Specifically, the need for high upfront investment, the dependency on market supplies, scepticism around the adoption of alternative construction materials and technology, determining their affordability for their target market and a reliance on government intervention to facilitate this access to affordable housing. Reall, an affordable housing impact investor, has invested in the project to pilot the construction of 155 affordable pilots in Nairobi. The project was made possible through end-user finance offtake from an external investment, which was used to support a tenant purchase scheme targeted at the 30–50% income percentile range.

Source: Reall and Centre for Affordable Housing Finance in Africa. 2020. *Affordable housing in Kenya: market shaping indicators.* https://reall.net/wp-content/uploads/2021/05/Kenya-MSI-Country-Profile.pdf

To substitute structural cement and steel in the construction of residential buildings to meet the urban population by 2050, an additional 675 million m^3 of wood would be required, valued at USD 135 billion.[9] This is assuming that 30 percent of the cement and steel used in building the structure for these buildings would be substituted. However, the sector is already at a deficit in the supply of wood for construction, and the development of plantation areas in the country has been stagnant. An estimated 6 million ha of plantation land would be required to fulfill this additional demand in the

[9] Dalberg Catalyst estimate.

United Republic of Tanzania by 2050. Natural forest timber contributes very little to the forest sector when compared to plantation timber. However, with large natural forest resources, the country could also benefit from establishing more productivity through sustainable forest management mechanisms to ease the deficit in wood supply (Ledger, 2017). This opportunity could generate 4.3 million jobs,[10] including not only additional construction employment but also in the plantation and wood processing sectors that would be developed to meet the wood demand.

The United Republic of Tanzania has already established policy measures that would support the realization of this opportunity to create an enabling environment for wood product value chains. The country has implemented policy reforms that support private-sector investment in the management and rehabilitation of plantations. The United Republic of Tanzania Forest Fund was launched in 2011 to provide financial support for forest conservation and sustainable forest management (Bromhead, 2012).

Investment in creating market linkages, industrial infrastructure, and increased operational capacity will also be needed to develop this opportunity. In the United Republic of Tanzania, wood plantations and harvesting businesses include small enterprises that could be used via tree-grower associations and out-grower schemes to improve access to roundwood in the forest sector. These market linkages could be further supported by improving road infrastructure in the country. Silviculture and plantation management capacity in the country is underdeveloped and will need upskilling. Most of these sawmills also operate at below 50 percent capacity due to the limited wood supply, which has fortunately created a buffer for wood processing for increased wood supply upstream in the value chain. However, the machinery used by these mills and for harvesting should be upgraded to improve efficiency. The national government will be critical in enforcing regulations for the wood product subsector and introducing policies to incentivize the use of wood in construction and to advance the harvesting and processing of wood, as well as the use of engineered wood products, and in ensuring that wood unsustainably harvested from natural forests does not make its way into these value chains.

United Republic of Tanzania: opportunities, challenges, and risks

Challenges likely to be faced in the implementation of this opportunity include unclear land tenure systems, limited road infrastructure, and the high demand for wood from other countries in eastern Africa. All land in the region is owned by the United Republic of Tanzania, which has led to foreign investments being directed toward wood processing rather than the development of plantations in the country's forest sector. The lack of suitable road infrastructure also hinders the access of plantations to markets, which has also impacted investment plantations. There is also a high regional demand for wood from eastern Africa, which may impact the ability of the United Republic of Tanzania to meet local demand. Although efforts have been made in the region to develop plantation areas due to an increasing deficit in the supply of wood, progress has been slow due to barriers to accessing land in the context of the region's complex land tenure system.

[10] Dalberg Catalyst estimate.

Furthermore, efforts to meet the current housing deficit must not undermine the value of natural forests and plantations for biodiversity protection. The United Republic of Tanzania is one of the most biodiverse countries in the world and, for instance, accounts for 20 percent of the large mammals in Africa. However, the country has unfortunately lost at least one-third of its ecosystems in the last few decades (RTI International, 2021). It is thus important to conduct ongoing assessments on the state of forests in the United Republic of Tanzania as well as push for sustainable forest management to ensure that addressing housing deficits does not compromise the country's biodiversity.

Wood processing in Gabon

Introduction

Gabon has a significant forest sector and has made unique progress toward developing a sustainable and industrialized wood industry. Although this has included strengthening wood processing,[11] the progress made has largely been in primary processing activities. The country has one of the highest forest-area land-coverage proportions in the world, and timber is the country's third largest export, accounting for 9 percent of export value in 2019. Africa however faces a trade deficit for wood products that is expected to grow. While Gabon trades timber products with 19 other African countries, only 5.7 percent of intra-African trade is attributed to the country (ibid.). The processing opportunity lies in further developing the wood sector in Gabon by driving the development of secondary and tertiary wood processing to meet local demand and increasing export to other African markets, which are significant importers of these products.

The production of roundwood in the country has been declining, whereas the export-oriented wood processing industry has grown through the increased production of sawnwood and veneer sheets. This trend was established by policy interventions on the export of unprocessed roundwood, which promotes value-added activities in the wood sector. Eighty-eight percent of gross wood exports from the country have domestic value-add. A special economic zone was established for the processing and export of wood products, which has also supported the expansion of the wood processing sector in the country. Despite this domestic capacity in primary processing, there is still potential to better develop secondary processing activities.

Almost all industrial wood in Gabon is sourced from natural forests harvested by licensed concessionaires, who are required to adhere to 20-year to 30-year rotation cycles and sustainable forest management plans. About 40 logging companies extract about 1.7 million m^3 of timber annually (Conseil National Climat, 2021). Of the 400 tree species in Gabon, okoumé is the flagship wood species in Gabon out of the 24 species that are harvested and accounts for 60 percent of roundwood produced (Conseil National Climat, 2021; Timber Trade Portal, n.d).

The country experiences challenges in terms of compliance with regulations in the forest sector and illegal forest harvesting. Besides having the policy in place to counteract this, Gabon also intends to consolidate smaller logging companies in an effort to better enforce compliance with regulations and forest certification requirements, as illegal logging remains a driver for forest degradation in the country (Association Technique Internationale des Bois Tropicaux, 2021b). In addition to the ban on exporting unprocessed wood, the country has also banned the export of three species of high-value wood products (moabi, ozigo, and kevazingo) that mainly export to China, in an effort to further curb illegal logging (Business Africa, 2019).

[11] There are four stages of processing for wood products: the first is the production of roundwood; the second involves the primary processing of the sawnwood, veneers, and plywood; then comes secondary processing, which includes drying and machining to produce moldings, furniture, and finished products for construction; and the final stage is the tertiary processing required to manufacture paper and paperboards (African Natural Resources Centre, 2021b).

The case for wood processing in Gabon

The production and export of wood products that have undergone primary processing (plywood, sawnwood, and veneer) has grown by a CAGR of 9 percent respectively between 2015 and 2019. Exported wooden furniture, which dominated the category of secondary processed wood products, grew by 12 percent over the same period (International Tropical Timber Organization, 2021).

With a well-established primary processing industry for wood, Gabon has the opportunity to create increased value-add by also developing the secondary processing sector. The country has the opportunity to create USD 3.8 billion and USD 24 million in value-add in primary and secondary processing activity. Forestry has low levels of female employment (9 percent of total employment in Africa) and an increase in secondary and tertiary processing activities is also likely to increase the number of women employed in the sector (FAO, 2014).

Figure 9. Spotlight 2 – Gabon policy interventions

Spotlight: Impact of policy on Gabon's wood processing industry

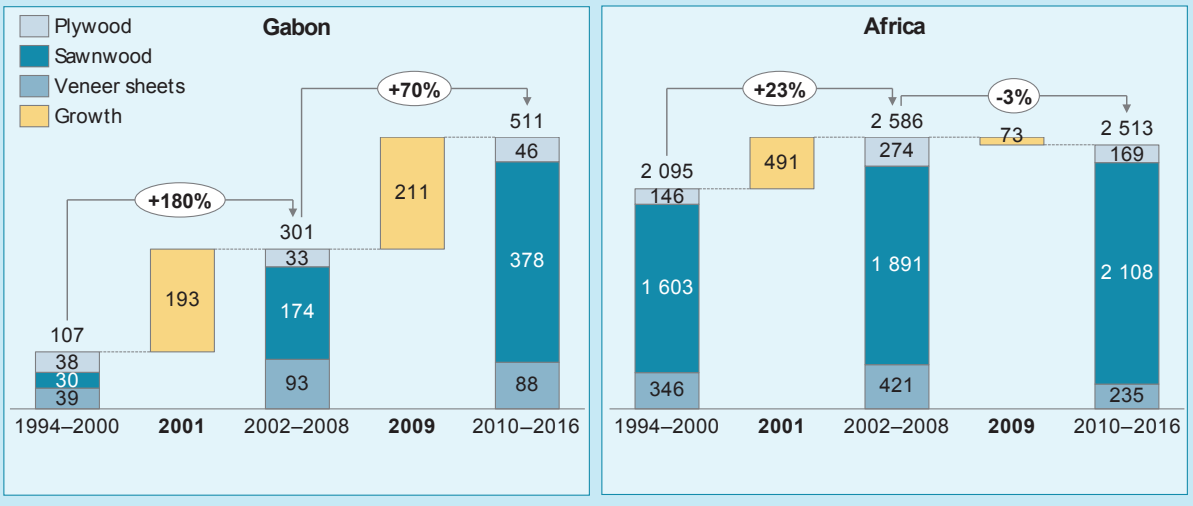
In **2001** Gabon implemented a new forest code that set a target of 75% of wood exports by 2009. Without sufficient progress, later in **2009** a government ban on all exports of unprocessed roundwood started to come into effect 2010, and was fully implemented in 2011.

The production of primary processed wood, specifically plywood, sawnwood, and veneer sheets, in Gabon has shown significantly more growth than the regional averages.

The growth in Gabon between periods stipulated in the forestry policies were implemented was 180% and 70% consecutively, whereas African exports increased by 23% and decreased by 3% over the same periods.

Average annual export of primary processed wood

Export quantity ['000 m³), 1994–2016



Source: Conseil National Climat. 2021. Gabon policy interventions.; FAO. 2021. FAOSTAT: Forestry Production and Trade. [Accessed on September 2021]. https://www.fao.org/faostat/en/#data/FO. Licence: CC-BY-4.0.

Gabon has used policy reform to establish an enabling environment for wood processing in the country. The special economic zone established for the wood processing sector provides fiscal incentives to investors that include tax-free operations for 25 years and

exemption from custom duties on the import of machinery (Privacy Shield Network, n.d.). The wood industry is targeted as one of the main pillars of development in Gabon's "Emergent 2025" national strategy, which aims to move Gabon towards emerging market status by 2025 (Islamic Development Bank, 2019).

More recently, the government introduced a policy requiring all forest concessionaires to be certified by the Forest Stewardship Council, which certifies environmentally appropriate, socially beneficial, and economically viable forest management. The country also aims to continue this positive trajectory for the wood industry by developing eucalyptus plantations and limiting harvesting from the country's natural forests (Association Technique Internationale des Bois Tropicaux, 2021b). They aim to establish an additional 200 000 ha of plantation forest by 2025 (African Natural Resources Centre, 2021b).

Other countries in the central African region are also positioning themselves to follow the lead set by Gabon. The Economic and Monetary Community of central Africa aims to create special economic zones in the region and to develop regulations designating a subregional university as a dedicated institution for professional training in wood trades (Association Technique Internationale des Bois Tropicaux, 2021a).

Gabon: opportunities, challenges, and risks

Despite the policy infrastructure in place, the current levels of skills and capacity for both primary and secondary processing in Gabon and the central Africa subregion pose a challenge to realizing the opportunity for improved wood processing. Secondary processing facilities lack the skill and certification standards to access markets like Europe. Furthermore, technology is limited, and capital has been a barrier to investment in the sector. Additionally, the logistics incur significant costs for wood products in Gabon due to the inefficient road network infrastructure, making it difficult to maintain competitive pricing. Transport infrastructure development in the country would also aid the opportunity.

Sustainable wood harvesting must underpin efforts to establish wood processing capabilities otherwise the country may risk its commitments to preserve its forestry resources for carbon absorption. The country's forestry ecosystem is well positioned to be a leading actor in climate change mitigation in the region; for instance, Gabon is the first country in Africa to receive results-based payments for REDD+ (Africa Forest Forum, 2019; Africa Renewal, 2021). As such, there is a need for establishing firm climate change-focused forest management protocols in parallel to building wood processing capabilities.

Forest-based ecotourism in South Africa

Introduction

South Africa has one of the largest travel and tourism economies in Africa, and like many other countries, the sector has been significantly impacted by the COVID-19 pandemic. In 2020, South Africa's travel and tourism sector contributed USD 11.1 billion (3.7 percent of GDP) to the country, a 49.2 percent decrease from 2019. In 2019 domestic spending on travel and tourism in South Africa was in line with the global average, accounting for 55 percent, and rose to 67 percent in 2020 due to the decrease in international spend (World Travel and Tourism Council, 2020). As of mid-2021, even fully vaccinated South Africans are still barred or have restrictions on entering popular international destinations.

Domestic tourists also contribute to the majority of travelers in the country. However, the number of domestic trips has been declining since 2015, largely due to unfavourable economic conditions. The number of domestic trips decreased by 37 percent from 2014 to 17.7 million in 2018, while the number of international tourists grew by 10 percent over the same period. The majority of international tourists in the region originate from other countries in southern Africa (OECD, 2020).

Ecotourism is an important driver for employment and economic development in South Africa, and with the diversity of mammal and bird species present in the country, wildlife tourism in particular contributes significantly to the sector. The socioeconomic impact of the sector is also largely seen in rural communities often located near tourist sites. It is estimated that ecotourism creates 5 000 jobs a year for these local regions (Boren Magazine, 2018). The sector also links to the economic development of other sectors in the economy such as airlines, hotels, and creative industries. The sector is also critical in the support of conservation in the country: 80 percent of the country's South African National Parks budget is from tourism (Spenceley, 2021).

The case for ecotourism in South Africa

Prior to the economic shock presented by the COVID-19 pandemic, the travel and tourism sector in South Africa contributed USD 22.1 billion to the national GDP, and ecotourism was estimated to contribute USD 8.4 billion annually (Boren Magazine, 2018; World Travel and Tourism Council, 2021a). In 2017, the travel and tourism sector employed 722 012 people, contributing 4.5 percent to the country's labour force. Employment in the sector grew by 2 percent annually between 2014 and 2017. About 41 percent of those employed in the sector are female, but this number is higher for the food and beverage serving and accommodation subsectors where over 60 percent of those employed are women (Stats SA, 2018).

South Africa has the opportunity to improve domestic ecotourism to contribute USD 24.7 billion to the tourism sector by 2050, should the travel and tourism sector in the region recover from the economic shock of the COVID-19 pandemic by 2024. This would result in 1.9 million jobs over the same period. Unlike traditional forest-linked economic sectors such as the wood industry, this boost in ecotourism has the potential

to significantly boost female employment. This opportunity would also allow the sector to develop resilience against future international or global economic shocks.[12]

Figure 10. Spotlight 3 – Zaina Lodge

Spotlight:	**Zaina Lodge**, a Ghanaian luxury safari hotel
Zaina Lodge is located in Mole National Park, an area of savannah and forest. The hotel opened its doors in 2015, aiming to attract tourists from west Africa and promote domestic tourism to the destination. The company also aims to run its operations sustainably.	As a hotel that marketed itself as a destination for domestic tourism, Zaina Lodge was less impacted by the drop in international tourism spend that occurred in 2020. The enterprise had to release its staff in the early months of the COVID-19 pandemic, due to a presidential order to halt operations. However, driven by a strong domestic client base, December 2020 was the second-best month on record for the enterprise.

Source: GNA. 2015. Zaina Lodge at Mole Park to open in September 2015. https://www.modernghana.com/news/626476/zaina-lodge-at-mole-park-to-open-in-september.html

As a major economic sector, South Africa has a dedicated tourism strategy that focuses on marketing, management, ease of access, visitor experience, and broad-based benefits. The country's tourism department has a dedicated marketing arm that promotes international and domestic tourism. About half of the national budget for tourism in South Africa is dedicated to destination marketing. In response to the COVID-19 pandemic, the government established the Tourism Relief Fund to provide support to tourism establishments for pandemic recovery.

Government and public-private partnerships will play a critical role in supporting the development of the tourism sector in South Africa. Domestic tourism in South Africa can be further stimulated by targeting middle-class families and so-called millennials through targeted marketing campaigns, investing in authentic experiences, and improving accessibility to these destinations. In some countries, governments have issued vouchers, subsidies, and discounts for travel and tourism, and have committed to promotional activities to stimulate the sector in the future (World Travel and Tourism Council, 2021b).

South Africa: opportunities, challenges, and risks

The periodic COVID-19 pandemic restrictions on mobility impact the tourism sector and will likely continue to do so as the government tries to contain the virus. The national government has also faced challenges rolling out COVID-19 vaccinations to the population, largely due to misinformation and distrust of vaccines. This threatens the recovery of the sector for international tourism and limits the extent to which local restrictions can be eased.

There is a risk that the new wave of ecotourism development in South Africa may not align with good practices of holistic ecosystem development. A study on ecotourism in South Africa highlighted a set of key principles of ecotourism that should be observed: sustainability, community involvement, local culture and heritage support, and promotion of mutual benefits (Menzies and Merwe, 2013). Establishing a set of standards and protocols for relevant actors would ensure that the growth of ecotourism does not infringe on the well-being of communities and species.

[12] Dalberg estimate.

Forest sector opportunities in Ghana

Introduction

Unlike the other case study countries, the pathway for growth of the forest-based bioeconomy in Ghana is currently not well positioned for the priority opportunities identified (wood processing, domestic ecotourism, or cement and steel building material substitution). Consequently, below we characterize the forest-based bioeconomy as a whole and identify a suitable pathway for development.

Ghana has seen high rates of deforestation and forest degradation. According to recent estimates by Kyere-Boateng & Marek (2021), cocoa production has been among the key drivers of deforestation in the country. Ghana has put in efforts to drive a transition to a more sustainable cocoa production landscape, while providing added incentives to farmers, traditional leaders, and communities that support landscape governance and management activities that reduce deforestation and support the adoption of climate-smart practices (Forest Carbon Partnership, n.d.a.). As a result, Ghana managed to achieve emission reductions of 972 456 tonnes of CO_2 from reduced deforestation and forest degradation in 2019 for which it received USD 4.86 million, making it the second country in Africa to receive emission reduction payments from the Carbon Fund (World Bank Group, 2023).

Ghana also has one of the highest shares of land designated for forest area, accounting for 74 percent of forest area. Ghana also is further characterized as having favourable climatic conditions and soil characteristics for developing forest production (African Development Bank, n.d.). Plantation forest area grew by an annual growth of 3.05 percent between 2010 and 2020, considerably more than the regional average of 0.8 percent (FAO, 2014).

The country has a significant informal forest sector that is almost equal to the formal sector. This is mainly due to the contribution of informal and illegal sawmills that provide the majority of the supplied timber in the domestic market. The sector largely consists of small and medium enterprises, which in addition to timber, provide NWFPs, ecotourism in rural areas, and agricultural produce via plantations. Forests contribute significantly to the livelihoods of an estimated 2.5 million of Ghana's rural population, providing food, medicines, clothing, shelter, furniture, and water, and an estimated 1.2 million are employed in the formal and informal forest sectors (FAO, 2014). Some of the larger employers make use of small-scale carpentry firms and illegal chainsaw operations (African Development Bank, n.d.). The formal wood industry value-add was estimated to be USD 1.3 billion, 80 percent of which is attributed to the production of roundwood. This is estimated to reach USD 2.7 billion if the informal sector is included (FAO, 2014).

Ghana is a net importer of wood products, as the high woodfuel production in the country constrains the local development of other wood value chains. The production of wood products in Ghana has shown little growth between 2015 and 2019, while the export and import value of forest products have increased annually by 6 percent and 16 percent respectively over the same period. The import of paper and paperboard is

the main driver for the country's import value, accounting for 78 percent of this value. Ninety-six percent of the roundwood produced in Ghana is used for woodfuel, higher than the regional average, contributing to the significant net import of non-fuel wood products (FAO, n.d.a).

Ghana's significant NWFPs include medicinal plants, bushmeat, rattan, construction material, and edibles like cola, shea, butter, and palm oil. The available medicinal plants in the country are used by both global and domestic markets. More than 80 percent of Ghana's population makes use of medicinal plants. Medicinal plants for international markets from the country are used as anti-HIV, male stimulant, ophthalmic and antimicrobial treatments (Agustino *et al.*, 2011). Bushmeat trade is another significant forest-based market in the country and is supported by an estimated 60 000 hunters (African Development Bank, n.d.).

The case for the forest-based bioeconomy in Ghana

Ghana has implemented several policies to support sustainable forest management, regulate the forest sector and provide an enabling environment for forest-based opportunities. This includes a Voluntary Partnership Agreement with the European Union that aims to ensure that imports from Ghana are sourced from sustainably managed forests, the Forest Investment Programme, a REDD+ Strategy, and the Forest Plantation Strategy, which aims to mitigate deforestation and degradation while also providing sustainable wood and NWFPs. Ghana also has a National Plantation Development Fund that aims to support the implementation of its plantation strategy (Kpelle, 2018).

Ghana can stimulate its wood industry by continuing to invest in forest plantations to secure the supply of wood for industrial purposes. The high dependence on woodfuel in the region not only drives deforestation but also limits the growth of the wood sector. At the current rate of growth of plantation area, Ghana could increase its plantation area from 297 100 ha in 2020 to over 500 000 ha by 2050. Through sustainably harvested wood, Ghana has an opportunity to ease the pressure on its natural resources for woodfuel and improve the supply of industrial wood to grow its production of wood products. The overcapacity downstream in the wood industry would also allow for easier integration of the additional wood supply into the wood processing sector.

Ghana could produce an estimated 9.2 million m^3 annually of wood from plantations, valued at an estimated USD 1.8 billion. This growth would also result in an estimated 34 000 jobs on plantations in the country.[13]

Ghana: opportunities, challenges, and risks

To improve the value of the wood industry, the country would benefit from additional policies to promote wood processing activities through incentive mechanisms used by countries such as Gabon. The country should also enforce current mechanisms used to mitigate illegal harvesting in order to support the transition to legally sourced wood. The significance of the informal sector incentivizes the government and investors to

[13] Dalberg estimate.

bring these enterprises into formal systems. However, it should be noted that it is difficult to incentivize informal enterprises to register with regulating authorities as costs are usually incurred when they join these formal systems. Mechanisms should be established to successfully monitor these enterprises.

6. Forest-based bioeconomy challenges and risks

Safeguarding against harm

There is a need to safeguard any bioeconomy-related interventions against the potential creation of harm. In their most successful cases, forest-based bioeconomies can contribute to cascading climate, social, and economic benefits, catalysing larger systems change. However, if incorrectly implemented, forest-based bioeconomies can result in significant unintended negative outcomes for societies, environments, and climate.[14]

Safeguard guidance has been developed for a wide range of actors and organization types. Although safeguard frameworks, certification, responsible investments, and other strategies exist, many do not directly acknowledge forest-based bioeconomies, necessitating thoughtful consideration. Existing guidelines range from theoretical framing (high-level principles and considerations) to specific metrics (e.g. indicators and tools), and are diverse in terms of audience and objectives.

As part of forest law enforcement, governance and trade (FLEGT) Voluntary Partnership Agreements (VPAs) signed with the European Union, tropical timber-producing countries, such as Ghana, have established national timber legality assurance systems (TLAS). These systems have been designed to verify compliance with a set of commonly agreed legality requirements that are based on the national legal framework and go beyond the legality of timber extraction and processing by verifying compliance with social and environmental requirements, such as respecting labour rights and avoiding water pollution and forest disturbances. The VPA also requires the development and implementation of a safeguard or monitoring system to measure the impact of the agreement on the level of illegality, forest condition, livelihoods, economic development, and trade. This allows decision-makers to address the potential adverse impacts of the VPA on local communities, small businesses, and the environment. In many cases, VPA processes have resulted in the strengthening or establishment of systems for the redistribution of forest revenues with forest communities affected by logging operations, compensation schemes for damage to crops from logging activities, and an additional source of funds to be reinvested in social development projects within affected communities.

Three key issue areas underpin safeguards: ecosystem health and function, society and economy, and climate (Clay and Cooper, 2022). Although there are differences in the specific challenges and risks according to the scope, sector, and objective of the intervention, these cross-cutting issue areas remain consistent across all interventions. These issue areas can be considered on a spectrum, with the potential to both mitigate harm and promote co-benefits on the one extreme, and the aim of reducing negative impacts on the other extreme. The priority of the issue area is typically determined by the assumed risk for the project type and geography, ensuring actors can focus their efforts on their most pressing areas of concern.

[14] Social and environmental safeguards can be broadly defined as measures taken to prevent harm by continually assessing, monitoring, and, where possible, improving the social and environmental impacts of interventions relative to the baseline scenario (Clay and Cooper, 2022).

Ecosystem health and function

Conserving biodiversity, maintaining and restoring ecosystems, and sustainably managing natural resources are the foundations of sustainable development. Biodiversity is fundamental to life on Earth, regulating the climate, underpinning food and water systems, and balancing our ecosystems. In an increasingly interconnected world, biodiversity has become core to our societies, affecting not just our natural environment (including the air we breathe and water we drink), but also what products we buy, how we live, and what jobs we have. As the term covers the diversity within species, between species, and of ecosystems, it attempts to "reflect the variation of, and interaction among, all life on Earth" (IISD, 2019).

Healthy ecosystems and biodiversity provide the essential resources and services necessary for societies to operate. Biodiversity directly affects many key economic industries for countries, particularly in the Global South, including agriculture, forestry, fisheries, and tourism. It is fundamental for sustainable food systems to ensure food security, agricultural productivity, soil fertility, and water quality and supply. However, it also affects many unexpected areas of our societies beyond "nature", including health. Not only does a healthy ecosystem provide the key enablers for a healthy population (clean air, water, and fertile soil), but it is also the source of both modern and traditional medicines. The potential of a healthy ecosystem is transformative – it can be the source of energy, infrastructure, food, and economic prosperity (IISD, 2019).

However, without appropriate safeguards in place, the growth of a forest-based bioeconomy could damage ecosystem health and function. Global trends towards urbanization, increased consumption, and human population growth have driven the destruction and degradation of nature. To date, the biggest driver of biodiversity loss has been land-use change, particularly converting natural habitats into agricultural systems, including within forest-based bioeconomies. Although there is no single measure that can capture how much biodiversity human activity has destroyed, the vast majority of indicators show net declines over recent decades. The 2020 Global Living Planet Index shows a 68 percent decline in monitored populations of key species between 1970 and 2016, showing a worrying trend for overall ecosystem health (World Wide Fund for Nature, 2020).

For example, unsustainable and illegal harvesting from natural resources threatens the future supply of wood and NWFPs. Illegal and informal harvesting in Africa impedes the transition to sustainable harvesting and distorts data on production and trade flows monitored by governments and investors, and the future supply of forest products from these natural resources. The region needs safeguards against illegal activity, and mechanisms for monitoring informally used stocks of harvested materials. This will allow for the correct interventions to be put in place to support the sustainability of forest resources and direct current resources accordingly.

In this light, FAO has supported several African countries in putting TLAS in place in the context of VPAs signed with the European Union. TLAS development and implementation are aimed at strengthening the regulatory framework and the capacity of governments, the private sector, and civil society to jointly contribute to the reduction and monitoring of illegalities along the wood production value chain. TLAS includes a

legality definition of what constitutes legal wood and states the agreed-upon aspects of national law against which the timber legality assurance system evaluates compliance for FLEGT licensing. These systems must also specify supply chain controls to ensure that timber products verified as legal remain legal throughout all processes associated with the supply chain. Supply chain controls also prevent verified legal products from being mixed with unverified products entering the supply chain. TLAS includes third party verification or audits at the operator or system level to ensure the robustness of the system and satisfaction of all the requirements established by the legality definition and supply chain controls and that resulting timber products are legal. Some countries include independent forest monitoring by civil society organizations or Indigenous Peoples to further strengthen the implementation and forest governance of TLAS.

Using a compilation of existing safeguard frameworks, ecosystem health and function can be assessed at a project, national, corporation, or supply chain level (Clay and Cooper, 2022) to identify and use reliable tools for safeguarding.

Society and economy

Ensuring appropriate links between communities, their well-being, and nature is essential for any forest-based bioeconomy. This includes a range of societal indicators on individual and communal impacts of the intervention (including labour rights, working conditions, gender equity, participation, Indigenous Peoples, etc.), as well as access to resources and related well-being, poverty reduction, work opportunities, and potential risks to the local economy.

Society and economic impacts are complex issue areas to assess, including aspects such as economic livelihood impacts, food security, labour and working conditions, illicit activities, and cultural heritage alignment. It is critical to assess the relationship between people and nature, particularly given the large percentage of Indigenous Peoples and smallholder agriculturalists that are highly dependent on forest biodiversity for their livelihoods and well-being. The relationships between Indigenous Peoples and local communities and forests remain important and must be critically assessed as access to markets (both locally and globally) grows for forest products. Safeguarding against unintended negative consequences for both communities and their economic well-being will be critical to align with both global human rights and environmental agendas.

For example, secure and clear land tenure continues to be an obstacle to the sustainable use of natural forest resources in Africa. Only about 10 percent of land area in Africa is publicly registered: the remaining 90 percent is under customary law and is governed by customary traditions (Byamugisha, 2016). These regimes are often undocumented and therefore unclear to investors for the implementation of forest-based activities. Local communities are also often dependent on this forest land, creating a more complicated resource-sharing dynamic for these activities, as demonstrated by the high level of land disputes in the region. Nevertheless, reforms to combat the barriers presented by land tenure systems in Africa have taken place on the continent, presenting good practices on accelerating titling and registration of land, increasing the transparency of land transactions, and formalizing the ownership of communal land to clarify issues around ownership and associated rights.

Climate

For a successful realization of a forest-based bioeconomy, the net impact on the climate should be positive, including GHG emissions, carbon sequestration, adaptation and resilience benefits, and potential for reversal or leakage of emissions to areas outside of the focus intervention.

While these indicators are not yet commonly included in existing safeguard guidelines, this is typically the area where a forest-based bioeconomy has the greatest impact. For any intervention to be considered as part of the sustainable forest-based bioeconomy, it should be measurably climate beneficial, leading to no unintended GHG emissions, and, critically, no forest loss.

Additionally, Africa's high demand for woodfuel continues to be a contributor to deforestation in the region. Despite the significance of woodfuel, it is largely overlooked in the continent's energy agenda, even as modern renewable energy sources such as hydropower and solar are being developed. There is limited evidence of how the transition to modern renewable energy sources will displace the use of fuelwood and there is limited investment to improve woodfuel supply chains on the continent. As mentioned, 63 percent of the population in Africa is reliant on biomass – primarily wood energy for cooking. To address this dependency there has been investment into the alternative use of energy sources such as gas stoves for cooking in the region. However, only the region's affluent inhabitants can afford to use gas due to its price and availability, so low-income households continue using fuelwood and charcoal. Large-scale and influential initiatives such as the African Forest Landscape Restoration Initiative (AFR100) have come to acknowledge that without access to fuelwood alternatives, efforts should be made to establish sustainable woodfuel value chains in many regions in Africa. There have also been successful agroforestry schemes in Africa able to produce sustainable woodfuel (Schure, 2019).

Challenges to sustainable growth

Furthermore, the study explored a set of challenges that may impede the growth of the forest-based bioeconomy and limit actors' ability to pursue the identified opportunities, if left unaddressed, on both the supply and demand side.

Africa's wood deficit is expected to grow, and developing a sufficient local supply of wood to meet the expected demand for opportunities presented will be difficult. This demand for wood would have to be met by shifting wood intended for short-term use, such as fuelwood, paper and paperboard towards long-term subscription such as mass timber, and by supplementing the supply of wood through plantation forests dedicated to the sector. For Africa, promoting the use and supply of alternative renewable energy would greatly impact the designation of wood for energy in the region. This would be particularly difficult, yet essential in rural areas where alternative energy forms are scarce. Africa would need innovative models to meet the demands of these communities, while addressing the challenges of limited income and limited access to supply chains, and also incentivizing the energy source switch in these areas. Both the private and public sectors would be required to address these barriers, through policy interventions in

the construction, energy, and forest sectors to incentivize these changes and promote private-sector investment.

Furthermore, the availability of the right inputs for the growth of the supply of sustainably harvested forest products remains challenging across the region. Ensuring access to the right quality and type of tree species is consistently highlighted as a major roadblock for many forest managers, as there is a lack of nurseries across the region. Additionally, for trees outside forests, many actors have highlighted the challenges for smallholder farmers. These farmers typically plant trees alongside other crops, and face issues with both education and access to the inputs needed for the right quality outputs, come harvest. Some regions, including in eastern Africa, have lost years' worth of harvest due to poor-quality inputs, which are only identified five to seven years later. Targeted investment in the availability of high-quality, sustainable supply is essential, both with large corporates and with smallholder farmers across the region.

The limited use of emerging technology continues to be a barrier to the development of the forest-based bioeconomy in Africa. The manufacturing sector is still developing its industrialized capacity in most parts of the region and is restricted by the use of inefficient technology and costly operations. Subsectors such as wood and tree crop harvesting and processing are impacted by systems that threaten the productivity of the bioeconomy sector. The region has also been slow to adopt emerging technology, such as the internet of things and artificial intelligence, thus exacerbating the digital divide between the continent and developed markets. Forest sector models and mechanizations need modernization and investment to improve incomes and meet the growing domestic and international demand for forest products.

Limited access to skills and labour is also a barrier to pursuing the opportunities identified. Africa continues to score below average on indicators for developed and developing countries in terms of people's technology preparedness, such as education levels and internet access. The labour market in the region will restrict the extent to which improved and innovative technology systems that require higher-level skills can be implemented. Significant intervention would be required to train and upskill future labourers and to provide technical assistance to forest sector businesses. This would also improve the socioeconomic impact of the sector by employing local and vulnerable populations for these high-skill jobs.

Risks and proposed mitigation

Similar to other previously underdeveloped value chains, current non-market supportive interventions in the forest bioeconomy are often siloed. Siloed programming and interventions in turn impose the risk of duplication. For instance, architects and cities engage in wood construction programs assuming that the supplies from certified forests will automatically follow. On the other hand, forest managers don't anticipate the future needs of wood and as such, they also miss financial resources to improve the sustainability of their forests. There is a need for more coordination to leverage synergies and avoid duplicative efforts.

The opportunities presented in this report have unique potential risks to their implementation. Some of the key risks as well as potential mitigative interventions are presented in Table 5.

Table 5. Key risks of opportunities in the African forest-based bioeconomy

Sectors linked to the forest bioeconomy	Opportunities	Risks	Mitigation
Cross-cutting	All	• The growth of a forest-based bioeconomy could damage ecosystem health and function. • Unsustainable harvesting from natural resources threatens the future supply of wood. • Limited access to skills and technology jeopardizes actors' ability to pursue identified opportunities.	• Ecosystem health and function can be assessed at a project, national, corporation, or supply chain level • Actors need safeguards against illegal activity, and mechanisms for monitoring informally used stocks of harvested materials. • Significant intervention would be required to train and upskill future laborers and to provide technical assistance to forest sector businesses. • Forest sector models and mechanizations need modernization and investment.
Agriculture	Scaling agroforestry for smallholder farmers	• Agronomic practices for tree crops require msts and skills for maintenance that threaten the growth and development of these schemes after initial phases of development, and the delayed return on investment may diminish interest from farmers.	• Providing continuous investment, technical assistance and advocacy, until the trees bear crops, would support smallholder farmer buy-in until the benefits of agroforestry can be seen.
	Tree crop cultivation and commercialization	• Monoculture of high-return tree crops poses a risk to crop diversity. This creates challenges in over-production of crops, pest control and increased use of pesticides and fertilizer, which in turn impact on produce and supply chains in the region. • Increased agricultural expansion could increase deforestation and impact the water availability, biodiversity and functions of landscape ecosystems.	• Most external stakeholders would have limited influence on the tree crops grown. However a variety of produce buyers such as reatilers and aggregators/off-takers would ensure a variety of crops are grown. Other stakeholders could ensure the availability of safe pesticides and secure fertilizer value chains so as not to restrict supply for others farmers • Ensure the monitoring of forest area where tree crop cultivation is expanding.
	Gathering of NWFPs	• Overexploitation of natural resources providing NWFPs. • Homogenization of natural and cultural landscapes.	• Develop sustainable management, conservation and restoration of wild plants and associated ecosystems, including practices enhancing pollination services. • Promote functioning nutrition-sensitive and biodiversity friendly consumption and production/value chains. • Ensure an enabling institutional and socioeconomic environment, including access to knowledge and information at all levels.
Energy	Forest residue biofuel (circular opportunity)	• Wood residue is likely to be sourced from multiple areas to reach sufficient scale for cost-effective production. • The impact of GHG emissions when transporting residue poses a risk to the positive ecological impact of the circular system, particularly where wood systems are scattered.	• Conduct logistics planning and model the carbon benefits where these systems are being promoted.
Construction	Cement and steel building material substitution	• Overharvesting and illegal logging could occur to meet demand for wood by the construction sector.	• Conduct planning for the supply of wood by ensuring enough sustainable forest harvesting is occurring with effective safeguards in place, and that plantations are developed to meet any wood deficits. Strict monitoring for the flow of wood will ensure harvesters and buyers of illegal wood are held accountable.
Health	Bioprospecting	• The limited formalization of traditional knowledge could lead to biopiracy in the region, where the intellectual property of Indigenous Peoples is exploited.	• Align to best practices established in similar environments such as South America in order to establish adequate legislature on the nascent industry before it gains traction.
	Collection (wild or otherwise) and commercialization of medicinal and aromatic plants (MAPs)	• Increased availability of MAPs could increase their use, and threaten the use of formal therapies for medical conditions. This risk would be particularly high for medicinal plants whose efficacy has not been proven or is not sufficiently potent for the medical conditions they are used to treat.	• Governments should continue to monitor the use of traditional medicines and combat mis/disinformation where intervention is required • Promote the sustainable management, conservation and restoration of MAPs and associated ecosystems, including practices enhancing pollination services.
Services	Carbon markets	• Conflicts stemming from traditional and statutory rights - a particular risk because of land tenure in Africa. • Inequitable distribution of benefits and burdens for REDD+ projects. • A need for international agencies to implement projects, conduct measuring, reporting and verification and broker sales diverts employment to international markets and could lead to elite capture for carbon markets. • As an unfamiliar market, carbon sequestering and trading may have unclear regulatory systems for countries in Africa, threatening the sustainability of these projects.	• Advocacy and campaigning to promote REDD+ projects should also be directed to government, as policy interventions would be instrumental in avoiding many of these risks, particularly advocating for: » Land tenure rights for these types of projects; » Benefiting sharing structures, protecting both local communities and project implementers and supporting the development of the high-skill labourers required over the value chain of these systems; » Legislature on stakeholder involvement for carbon sequestering projects; and » How the flows of funds from these projects integrate into a country's financial systems.
	Domestic ecotourism	• Decrease in the expected growth or recovery of the tourism sector if development of the sector is only targeted at domestic travellers, as they usually account for less spend per capita.	• Marketing for international ecotourism should also continue.
Manufacturing	Cross-sectoral wood processing	• Overharvesting and illegal logging could occur to meet the demand for wood by the manufacturing sector.	• Conduct planning for the supply of wood by ensuring that enough sustainable forest harvesting is occurring with effective safeguards in place, and that plantations are developed to meet any wood deficits. Strict monitoring for the flow of wood will ensure harvesters and buyers of illegal wood are held accountable.

Sources: Authors' elaboration based on Do, H., Luedeling, E. & Whitney, C. 2020. Decision analysis of agroforestry options reveals adoption risks for resource-poor farmers. *Agronomy for Sustainable Development*, 40(3): 20.; Parr, K. & Lehman, C. 2019. When tree planting actually damages ecosystems. In: *The Conversation. Melbourne, Australia*. [Cited on 2021]. https://theconversation.com/when-tree-planting-actually-damages-ecosystems-120786.; Anderson, J., Hespeler, E. & Zwiren, S. 2017. Monocultures in America: a system that needs more diversity. In: *Debating Science*. Massachusetts, USA. https://websites.umass.edu/natsci397a-eross/monocultures-in-america-a-system-that-needs-more-diversity/#:~:text=Monoculture%20fields%20lack%20biodiversity%2C%20which,and%20lack%20of%20natural%20predators.; Loft L,. Pham, T., Wong, G, BrockhauS, M., Le, D., Tjajadi, J. & Luttrell, C. 2017. Risks to REDD+: potential pitfalls for policy design and implementation. *Environmental Conservation*, 44(1): 44–55.

7. Recommendations

Promoting a forest-based bioeconomy could offer significant environmental, ecological, and socioeconomic benefits. Forest-based bioeconomies, based on sustainable forest management, have the potential to curb the effects of deforestation while creating local economic value and job opportunities. The key lies in realizing the significant opportunities for the development and nurturing of forest-based circular bioeconomies, which can be interpreted as economies that place biological resources at the centre of their circular production cycle.

However, the creation of this forest-based bioeconomy faces many challenges. A major challenge in the region is the high forest loss due to agricultural expansion, logging, mining, fuelwood collection, and other factors. Africa has also not sufficiently integrated value-add industries along forest value chains and continues to rely on the trade in primary products of forest resources. Before any action is taken as a result of this report, a thorough supply-side analysis should be conducted, to ensure market growth remains within the natural limits of the ecosystem.

Key barriers that need to be overcome to ensure sustainable and inclusive growth are:

- **Unsustainable and illegal harvesting from natural resources threatens the future supply of wood and NWFPs.** The region needs to safeguard against illegal activity and mechanisms for monitoring informally used stocks of harvested materials, allowing the correct interventions to be put in place to support the sustainability of forest resources. In pursuit of industrialized value chains, countries also need to manage their sustainability goals and promote regenerative cycles.
- **The limited use of emerging technologies continues to be a barrier to the development of the forest-based bioeconomy in Africa.** Forest-sector models and mechanizations need modernization and investment to improve incomes and meet the growing domestic and international demand for forest products.
- **The limited access to skilled labour** is also a barrier to pursuing the opportunities identified, requiring significant intervention to train and upskill future labourers and to provide technical assistance to forest sector businesses.
- **Unclear land tenure** continues to be an obstacle to the scaled monetization of natural forest resources in Africa. Nevertheless, reforms to combat the barriers presented by land tenure systems in Africa have taken place, presenting good practices on accelerating titling and registration of land, increasing the transparency of land transactions, and formalizing the ownership of communal land to clarify issues around ownership and associated rights.

To further develop the forest-based bioeconomy in Africa, the necessary measures would include:

- **Establish innovative public-private partnerships**. These would be required to address the above-mentioned barriers and transform Africa's forest-based bioeconomies. Further research is required into the supply of sustainably harvested forest products. Both the private and public sectors will be crucial in addressing

these barriers to sustainably growing the forest-based bioeconomy in Africa. The continent has an opportunity to leapfrog towards linked and efficient systems for the sector, mitigating fragmentation in the development of the sector through consolidated efforts from these stakeholders. Africa can seek to strengthen or establish platforms for collaboration and partnership between countries to allow policymakers to learn from each other as they try to address existing and emerging challenges. Additionally, further research into the availability of sustainably harvested forest products, including mechanisms to improve both the sustainability and ecosystem health of the sector, is essential before any further action is taken.

- **Industrialize the wood industry.** Africa has wood-rich natural forests and a wood industry that would benefit from industrialized harvesting and processing sectors. Harvesting and processing activities in the region have been seen to use outdated technology and inefficient practices, resulting in material wastage, increased product prices, and limited capabilities to produce high value-added wood products. The present supply of wood in the region is not being unlocked to optimize the socioeconomic impact it could have on the continent. The wood industry requires technology and skills to produce quality and well-priced wood products that are presently imported and meet these demands for the market through sustainable value chains.
- **Develop sustainable plantations to supplement Africa's wood deficit.** In the past, the potential of plantations to meet the demand for industrial wood and fuelwood for the region has often been overlooked. Compared to other regions in the world, there has been insufficient investment into developing sustainable plantation forests in Africa, despite the potential impact an increased supply of wood would have on natural forest resources, socioeconomic improvement for local communities, and benefits for downstream value chains. As a form of potential rural economic development, through both agroforestry timber schemes or the development of commercial lots by larger actors, developing these areas would also target vulnerable populations. It is also critical that plantations are not established near or on natural forest lands, but preferably located in cleared lands near urban centres. In other parts of the world, wood plantations have been rife with social and ecological problems, and awareness of these should inform any development of this sector in Africa.
- **Develop targeted bioeconomy policy and legislation**. Africa can prioritize bioeconomy-related policy and legislation to combat some of the challenges faced, or incentivize the opportunities presented in this report. Countries in Africa have come to recognize the significance of their natural forest resources and have put in place policies in support of sustainable forest management and forest area conservation. However, targeted policy, legislation, and law enforcement mechanisms to support this direction have not been sufficiently established in most countries. Understanding that many countries in the region face other pressing matters that require these government resources and that the forest-based bioeconomy is incredibly broad, these interventions would need to be contextualized to limit the demand for resources and may have to initially be adopted across existing government structures. For example, in tackling illegal harvesting, countries could put in place verification standards for wood stocks from

formal organizations that purchase from illegal entities. This would avoid the time-consuming and resource-heavy task of identifying illegal harvesting organizations while still capturing some of the illegal flows of goods from the fragmented informal sector. Policy on land-use rights for carbon sequestering projects would assuage risk-averse investors, and the establishment of special economic zones to incentivize local manufacturers and promote foreign investment would greatly impact the feasibility of opportunities in carbon markets and wood processing for the region.

- **Transform how wood energy is approached in Africa.** The way stakeholders operate in the energy sector in Africa needs to both address the challenges faced and acknowledge the positive socioeconomic impact of wood energy on the continent. Energy access is a challenge for rural populations and the urban poor in the region, and woodfuel is often the only accessible form of fuel for these groups and will likely continue to be in the medium term.

Interventions to limit the unsustainable and climate-detrimental use of woodfuel need to operate within these barriers. Instead of adopting isolated solutions, with limited reach, a nationwide two-pronged approach is needed to transform the energy landscape in African countries. Countries should develop sustainable wood value chains to combat current unsustainable practices, while also aiming to expand the reach and access to modern renewable energy to include rural and urban-poor populations. These populations depend on woodfuel because they lack access to existing electricity grid infrastructure and/or have sensitive price points. Sustainable woodfuel value chains could be created using modern technology, developing local manufacturing skills and good practices, and sustainably sourcing wood through sustainable forest management and commercially grown wood lots, limiting the detrimental impact of the use of woodfuel on the continent. And although scaled renewable energy systems are still in development in the region, they could be targeted at those who lack alternatives to woodfuel.

Simultaneously, it will be critical to ensure that biodiversity is maintained and improved, forest cover is expanded, and negative consequences for environments, ecosystems, and communities are minimized, to ensure sustainable, holistic growth.

FAO (2022c) proposed that countries, in collaboration with other partners, support the implementation of these recommendations by:

- supporting the development of low-carbon societies through increased carbon storage in forest products and substitution of high-carbon and fossil-fuel-based products;
- providing expertise for the development of targeted policies and legislations that promote a sustainable forest-based bioeconomy, including fostering the integration of forest products in nationally determined contributions;
- supporting capacity building for the development of effective sustainable forest-based industries, applying bioeconomy principles and cascading use to ensure sustainable consumption and production patterns of forest products; and
- supporting the development of evidence-based data and information on the future supply and demand trends of key forest products.

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8. Conclusions

Africa relies heavily on forests and forest-based economies for social and environmental benefits but is experiencing significant threats from deforestation and forest degradation. Forest products provide substantial contributions to the continent's social and economic growth. Over the past decade, Africa's forests have suffered the highest level of net forest loss globally, largely attributed to a growing population requiring more land and resources from natural forests.

The promising opportunities identified by the report for a sustainable bioeconomy in Africa derive from six key sectors – construction, manufacturing, services, agriculture, energy, and health:

- ***Construction:*** There is an opportunity to increase the use of sustainable mass timber for construction, given Africa's significant housing boom and growing construction need. With the population of Africa expected to double by 2050, an estimated 80 percent of the buildings needed by that time have not yet been constructed. Using mass timber for construction would meet Africa's housing needs while creating carbon sinks in the urban environment.

  The increased use of mass timber for construction has the potential to contribute up to an estimated USD 83 billion towards Africa's bioeconomy by 2050. An estimated 25 million jobs could be created through the additional plantations and processing facilities required to meet this growing demand.

- ***Manufacturing:*** The opportunity for increased industrialization and beneficiation has long been recognized in Africa. Bioprocessing and biorefineries in the region are largely limited due to the lack of technology, skills, and capital required for the specialized high value-added activities. Bioprocessing also presents an opportunity for the end-of-life use of by-products from primary sector forest activities, in support of a circular bioeconomy. However, significant investment will be required to increase the necessary wood supply, and access markets, technology, and skills required to pursue this opportunity.

  The wood processing sector could contribute up to an estimated USD 57 billion to the continent's bioeconomy by 2050, creating an estimated 29 million jobs. However, the development of this industry would need to be carefully tracked to ensure sustainable scale (i.e. ensuring that the market growth can be met by sustainably managed forests, ensuring no net forest loss).

  Services: A promising future for ecotourism in Africa can be driven by the growth of domestic tourism. There is also an opportunity for REDD+ activities in Africa for global carbon markets. While carbon markets and the tourism sector provide opportunities, both also face challenges. Although Africa was one of the first regions to pilot REDD+ activities, finance disbursement remained merely nascent in the region, largely due to enormous capital investment requirements and unclear land rights and regulations, largely because of a lag in developing an appropriate enabling environment, technical skills gaps as well as unclear tenure and property rights.

Ecotourism has the potential to contribute to an estimated USD 670–740 billion to the African bioeconomy by 2050, creating an estimated additional 45–50 million jobs. Carbon finance could support the establishment of some 13 000 jobs for local community members involved in REDD+ activities. Additionally, the implementation of REDD+ activities has the potential to avoid the loss of some 314 million $MtCO_2e$ annually.

- ***Agriculture:*** The opportunity for further upscaling of agroforestry in Africa has the potential to improve the socioeconomic and environmental conditions of smallholder farmers. Agroforestry has garnered interest in the region as a means to improve rural livelihoods for smallholder farmer households by diversifying incomes and providing greater ecological resilience. Additionally, agroforestry systems can support ecosystem restoration and landscape recovery by combating desertification and land degradation and easing the pressure on natural forest resources that are often subject to unregulated wild harvesting. The sustainable management and equitable use of wild plant resources provide opportunities to promote the development of nutrition-sensitive and biodiversity-friendly value chains. It can furthermore contribute to the conservation of traditional food systems that depend upon and enhance biological and cultural diversity.

  Agroforestry – specifically the production of fruits and nuts – has the potential to grow to an estimated value of USD 200 million in 2050, creating 19 million full-time jobs.

- ***Energy:*** Africa is highly dependent on woodfuel and also faces an energy deficit, creating an opportunity for biofuel in the region to effectively recover forest and wood residue. However, biofuel opportunities face barriers to implementation and raise environmental concerns. While energy crop plantations may be renewable, the land is often cleared through fires, and the production of biofuel often requires the use of fossil fuels. Scaling the use of forest residue also requires mobility for residue collection and transportation to processing mills, which is often a barrier, given insufficient economies of scale. There is a crucial prerequisite for the market linkages and physical infrastructure to source and transport feedstock without accumulating unsustainable costs for these biofuel opportunities.

  By 2050, forest residues in Africa have the potential to generate a market valued at USD 621 million in the form of wood feedstock, creating 90 000 jobs.

- ***Health:*** Although the forest-based health sector has significant value and potential in Africa, commercialization has been limited. Despite local and global demand for medicinal plants from Africa, the use and trade of these products is largely unregulated and informal. There is an opportunity to improve wild collection, cultivation, and commercialization of medicinal plants in Africa. Despite the growing demand for herbal medicines and the availability of natural resources in Africa, any opportunity in the sector will face significant barriers. These include: the unclear size of the opportunity and limited trade data, which impacts investment risk; and the lack of regulation and informality of current trade, which impacts links to large formal markets.

Traditional medicine, which relies heavily on forestry resources, could account for up to 16 million jobs in 2050.

Africa's natural and human capital provide unique opportunities to expand the forest-based bioeconomy and to become a driver of transformational change in the region. However, additional efforts from all stakeholders are required to address existing challenges and tap into its full potential. To realize this, Africa needs to take the necessary stipulated steps that will allow countries to advance a resilient and rapidly growing forest-based bioeconomy.

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Annex A. Modelling

Approach

The African bioeconomy opportunities identified have been assessed as business-as-usual forecasts for 2050.

Because the value chain links possible economic sectors, it should be noted that the continent-wide opportunities identified were assessed as siloed forecasts. For example, the wood processing required for the construction sector opportunity does not incorporate the supply of wood estimated for the manufacturing sector opportunity.

Definitions

Market size – The market size forecast for the bioeconomy opportunities identified is estimated as the USD value for the business-as-usual growth of the relevant sectors or subsectors mentioned.

Employment – The forecast for the employment generated from the opportunities identified is estimated as the direct and/or indirect opportunities that can be accounted for and is dependent on the availability of data to calculate the employment impact.

REDD+ – REDD+ refers to Reducing Emissions from Deforestation and Forest Degradation. According to the UNFCCC (n.d.a.), "'REDD' stands for 'Reducing emissions from deforestation and forest degradation in developing countries'. The '+' stands for additional forest-related activities that protect the climate, namely sustainable management of forests and the conservation and enhancement of forest carbon stocks. Under the framework with these REDD+ activities, developing countries can receive results-based payments for emission reductions when they reduce deforestation." In this report, REDD+ projects refer to on-the-ground initiatives aimed at reducing deforestation and forest degradation, conserving existing forests, promoting sustainable forest management, and boosting carbon stocks. The REDD+ process refers to the broader international framework and approach to addressing deforestation, forest degradation, and carbon emissions from forests at a global scale. It involves policy development, capacity building, and international cooperation to create an enabling environment for REDD+ projects and initiatives to be effectively implemented. African countries were among the first to enter the REDD+ process.

2050 projections: methodology

Annual data was extrapolated to generate directional models of estimations for the market value and employment in the relevant forest-based bioeconomy sectors in Africa. The information used includes data on opportunity and market trends, 2020 market size and employment data, market growth rates, and a set of practical assumptions (see Table A.1).

Assumptions

Table A.1. Modelling assumptions for 2050: projected numbers

Sectors linked to the forest bioeconomy	Opportunity	Major assumptions
Agriculture	Scaling agroforestry for smallholder farmers	Market size • Using a CAGR of 0.45% then increasing it to 1.5% and 2.5% in the following two decades • USD 701/ha/year increased it by the rate of inflation till 2020 – using an average rate of inflation of 5% Employment • 218 man days/ha/year is 1 FTE equivalent
	Tree crop cultivation and commercialization	Market size • Nuts include almonds, areca nuts, Brazil nuts, cashew nuts, chestnuts, hazelnuts, kola nuts, walnuts, pistachios • Fruits include bananas, oranges, tangerines, mandarins, clementines, satsumas, lemons and limes, grapefruit and pomelos, citrus fruit, apples, pears, quinces, apricots, peaches and nectarines, plums, grapes, watermelons, melons and cantaloupes, figs, mangoes, avocados, pineapples, dates, papayas • 30% of the total nut production is from smallholders for tree nuts Employment • 75% of the production is by smallholders for fruits • 30% of the production is by smallholders for nuts • 218 man days = 1 FTE equivalent
Construction	Cement and steel building material substitution	Market size • 80% of population growth will be in urban areas • 12 m^2 of residential space is required per person • Secure housing will be built for all persons • 50% of the additional dwelling units constructed are low rise, 30% of the additional urban dwellings will be mid rise, and 20% of the additional urban dwellings will be high rise • 30% of the steel and concrete in residential buildings can be substituted • Average industrial wood value in Africa is USD 200/m^3 • 70% of the industrial roundwood is allocated for construction and that allocation remains constant Employment • 1 house for every 6 people • 4 jobs created per new house constructed • 70% of the industrial roundwood is allocated for construction • 7 jobs per 100 hectares of plantation area • 1:3 multiplier of forestry to wood processing jobs
Services	Carbon markets	Market size • All deforested area is avoided and avoided deforestation land area remains constant • Voluntary carbon offset prices grow from USD 5-100/t/CO_2 from 2020 to 2050 Employment • 3.2 jobs for local communities per 1 000 hectares of REDD+ project forest area
	Domestic ecotourism	Market size • Rate of growth of the tourism sector spend follows the estimated growth of a maturing sector • Domestic tourism stabilises at 61.5% after the sector recovers from the COVID-19 pandemic • The ratio and growth of direct and indirect employment remains constant • Ecotourism spend and employment in the subsector are proportional within the tourism sector Employment • 2.5% annual growth of jobs in tourism • 1.7 multiplier for indirect jobs in tourism
Manufacturing	Cross-sectoral wood processing	Market size • 50% of the demand deficit can be met internally through increased forest supply and improvement in forest management practices • (1) Assuming in the 1st decade a majority of the industrial wood is used to satisfy primary processed wood products (PPWPs) (55%) since the majority of countries have this capacity already and export them, 30% is for secondary processed wood products (SPWPs) and 15% for tertiary primary wood products (TPWPs) as there is limited capacity. (2) In the next decade the proportion of SPWPs increases to 50%, PPWPs is 40% and TPWPs is 10%. (3) In the last decade SPWPs is 70%, PPWPs is 25% and TPWPs is 5% Employment • 7 jobs per 100 hectares of plantation area • 1:3 multiplier of forestry to wood processing jobs

Source: Dalberg Catalyst analysis, 2021.

Forestry Division - Natural Resources and Sustainable Production

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